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CONTENTS.

Editorial 677
A. I. E. E. International Electrical Congress Reception Committee..... 680
Incandescent Lamp Combination..... 680
Steam Turbine and Other Features of The Port Huron Light and Power Company's Station. By James E. Davidson..... 681
An Important Trolley System in New Jersey..... 686
Booster Calculations. By Wm. A. DelMar..... 687
High Tension Discussion in Chicago..... 690
Synchronous Converters. By F. G. Baum..... 691
The Telephone Substation—III. By Arthur V. Abbott, C. E. (Concluded.) 695
Current News and Notes..... 699
Letters to the Editors:
Steam Turbine Economy. By A. M. Mattice..... 700
British Technical Education. By Wm. A. DelMar..... 700
Digest of Current Electrical Literature..... 701
New Books 705
Recovery of Cylinder Oil. By Thos. Griswold, Jr..... 706
Storage Battery Installation at Binghamton, N. Y..... 706
Launch Motors and Controllers..... 707
Data on the Marconi Wireless Telegraph System..... 707
Rubber Compound for Electrical Purposes..... 707
News of the Week..... 708

ELECTRIFYING STEAM ROADS.

We have already called attention to the electrification of the Lancashire and Yorkshire steam railroad in England, and last week gave some further interesting data about this work. It is not to be forgotten that outside the Manhattan Elevated this is virtually the largest third rail system in the world, but of course the main interest lies in the change from steam to electricity. This is the first notable example of the kind in England, a country where a great deal more of the same development may be expected, even before it is attempted in this country. Indeed it is striking to note the elaborate figures made by Mr. F. F. Bennett in his recent paper before the British Institution of Electrical Engineers on the electrification of the steam railroads of England. He estimates a total annual expenditure of £13,939,646 or about $65,500,000, and a cost per train mile of 10.0479 penny, with a kilowatt cost of 1.2121 penny. This, he says, shows only an extra profit of 0.29 per cent., which he does not regard as sufficient temptation for making the change. But on the other hand he points to the great increase in traffic, sometimes fourfold, that follows the adoption of electricity, and claims that with an ultimate increase of capital of £300,000,000 to make the change up to its feasible limit of increase, the proportion of net receipts would be raised from the 3.279 per cent of 1901 to 5.1, or an increase in the profits of 1.831 per cent. This would represent an additional profit of £23,558,421 per annum. The complete paper is well worth close study and criticism.

BOOSTER CALCULATIONS.

In dealing with a long trolley feeder that is overloaded, we find that the pressure is unduly low at the distant end, where the feeder connects with the mains. Under these conditions one of two expedients must be resorted to for amelioration: Either more copper must be used or else a higher generating pressure. In the case of a trolley station, it may be impracticable to raise the pressure at the generators. In that event, there must either be more copper or a booster. There must be more conductance in the feeder, or an e.m.f. must be inserted in it. In many cases it is cheaper to put in the booster, and to increase thereby the drop and waste more power in transmission, than to sink investment in the copper and continue to lose the interest on the same. The article on page 687, by Mr. W. A. Del Mar, considers the various conditions controlling the installation and use of boosters.

There are two ways in which boosters may be applied to a trolley system. One is the ordinary way of raising the pressure at feeding points, or increasing the positive pressure. The other is in the application of boosters to the return circuit, in order to keep down the pressure more nearly to that of the ground. Such negative boosters, or depressors, are sometimes called "crushers." The difference, however, between a booster and a crusher is a mere matter of detail, and if instead of a ground return circuit, the return were entirely insulated, the difference would disappear. The value of a crusher is not merely for reducing the apparent drop of pressure in the ground return conductor system, but also for reducing or eliminating the dangers of electrolysis. The computations described for arriving at the most economical booster plant are very interesting. The cost per kilowatt of boosters is manifestly considerably in excess of the cost of generators, since boosters are of relatively small capacity, and require motive power as well as generator power. Boosters also add to the switchboard expense, and the general complexity of a system. Consequently, although boosters have proved a great boon to the electric street railway, they should not be installed without carefully counting the economies of the situation.

Synchronous Converters.

The modern converter is a wonderful machine from the standpoint of efficiency and convenience. It is in very extensive use, particularly in America, and it gives, as a rule, excellent service. It is a very compact machine and very light. That is to say, its output in watts per pound, or per kilogramme, is high relatively to that of the ordinary motor or generator. The reasons for this large output are that the machine is to a great extent a mere revolving commutator, and that during an appreciable part of the time in any alternating-current cycle, the alternating current is directly delivered from the collector rings on one side to the commutator, brushes and direct-current circuit on the other side. Moreover, in the polyphase converter, there is no appreciable absorption of mechanical power. The alternating-current power arriving on one side is converted into direct-current power delivered on the other side, without assuming the form of mechanical power as an intermediary step. In other words, neglecting frictions, the converter is devoid of mechanical torque. In this respect it approaches the conditions of the alternating-current transformer, which is stationary and devoid of torque, but which is, nevertheless, subjected to electromechanical forces of appreciable magnitude. These forces are rendered apparent when the coils are capable of moving relatively to each other, as in "tub transformers." It is surprising how large a proportion of our direct-current supply in large cities comes from alternating-current generators through the medium of converters. The theory of operation of converters thus assumes considerable importance. Part of this theory is covered by the article of Prof. F. G. Baum, appearing on page 691.

The relations between the voltages between collector rings on one side and commutator brushes on the other, are readily capable of being elucidated and apprehended. The heating of the armature winding under the differential action of the alternating and direct currents is, however, a complex matter. It has been worked out by Steinmetz, Child and others. A resumé of the computation is given in Prof. Baum's article, and shows the relative advantage of the six-phase converter. The article also gives the characteristic regulation curves of a particular small polyphase converter when employed as a shunt machine, and when compounded. It is shown that when compounded by the use of a series winding, the pressure at brushes is sustained much better under load than when the machine only employs a shunt field; but that, in order to make the pressure rise, reactance has to be inserted in the external alternating-current circuit. The manner in which the compound winding of the converter can cause the alternating current entering the machine to lead as the load comes on, and thereby force the pressure up at collector rings owing to the negative drop of the leading current in the reactances, is a very interesting well-known proposition.

Stroboscopic Methods of Observing and Recording Periodically and Rapidly Varying Phenomena.

In the January number of the *Journal* of the British Institution of Electrical Engineers is an excellent paper by M. E. Hospitalier on stroboscopic methods of observation and recording. Instruments for stroboscopic observation are called stroboscopes, and instruments which record stroboscopically are called strobographs. The ondograph of the author pertains to the latter class. A commutator is driven, with a definite small amount of asynchronism, by a small electric motor, and the commutator alternately charges a condenser from the periodically varying e.m.f. under test, and discharges the same through a measuring instrument. The latter moves a pen over a rotating cylinder, and, after about 1,000 cycles of the alternating e.m.f. completes a curve that practically represents every detail of variation in the wave.

There are several ingenious mechanical details in the apparatus. One is the avoidance of curvilinear co-ordinates in the traced diagram. When a D'Arsonval galvanometer is fitted with a lever arm and pen, the pen moves on the arc of a circle having for radius the length of the lever. A long arm makes a heavy and unwieldy lever. On the other hand, a short and manageable lever gives markedly curvilinear co-ordinates. In the ondograph, a long balanced pen-holding lever is operated by a short arm on the D'Arsonval galvanometer by a pin-and-slot connection. By this means the rectilinear diagram of co-ordinates is very nearly secured without encountering the mechanical difficulty referred to. By employing an electrodynamometer of the Thomson watt-hour-meter type for the recording instrument, the apparatus may also be made to record the cyclic curve of varying power in an alternating-current circuit, in addition to the curves of cyclically varying pressure and current.

The Electric Rigidity of the Atmosphere.

By far the cheapest and best insulator for high pressures in transmission circuits is air. It costs nothing more than the land beneath. It insulates alike the high-pressure, long-distance systems with many kilovolts, and the telephone wires that throb to vocally responsive voltages of but a volt or two. Of course, air insulation means practically air-and-glass, or air-and-porcelain, insulation, and at the glass or porcelain usually lies the rub. The race for high voltages in recent years has set even the atmosphere at its wit's ends to insulate the wires. Up to forty kilovolts, the spark-leaking distance of which is but a few centimeters, the air gives no trouble at reasonable distances between the wires; but above that limit the air is apt to take alarm and to coruscate with a cylindrical halo or corona that is very expensive to the station manager. The halo of a saint is always assumed by artists to be wattless, but the halo of a high-pressure wire may absorb many watts per foot. Consequently, as sixty kilowatts is already the existing commercial limit of pressure and there is talk of raising this yet further in the not-far-distant future, it becomes necessary to reckon with the air god as well as with the controlling spirits of glass and glazed earthenware. According to our modern views of electrolysis, air insulates like pure water, because it is in a stable molecular condition. There are no atomic valencies to satisfy in ordinary air or water. All the atoms are satisfied. But a disrupted molecule or a chipped atom thirsts for satisfaction and is subject to forces in electrostatic fields.

There are, however, limits to the stability of molecules. Jostle air molecules violently enough and they break up, or ionize. At the same time ozone is produced. At ordinary temperatures, and in the absence of energetic radiations, air molecules are supposed to jostle about with velocities of kilometers per second, but their collisions do not break up more than a few molecules per billion per second. Add, however, an electrostatic field, and the stability under collision is reduced. Lower the atmospheric density, so as to lengthen the mean free path, and give the electric flux more room to act between collisions; also increase the temperature of the air, and its mean velocity of molecular swing and the stability may be overcome. The air ionizes rapidly when the critical limits are reached, and the indicate that the critical voltage of brush discharge descends with from the wires. The recently published researches of Prof. Ryan indicate that the critical voltages of brush discharge descends with the air pressure, so that on transmission lines passing over high mountains the voltages that may be carried are markedly less than that which the same construction would admit of at sea level. Moreover, the danger of brush discharge diminishes with the size of the conductor, a large wire permitting of a higher voltage. This fact

favors aluminum wires. After all, at sea level, 100 kilovolts can apparently be carried with wires four feet apart, when the area of each of the wires is 40,000 circular mils. Since it is the top of the wave that counts, for producing halo, a flat-topped wave of voltage is less addicted to brush than a sine-wave or a peaked-wave, for the same effective voltage. On the other hand, the peaked-wave favors the reduction of hysteresis loss in transformers, while the sine-wave favors the elimination of resonant effects by harmonics.

The Question of Fire Risk.

The Institute discussion at the March meeting took a turn which most forcefully impresses the importance of precautions against fire. Modern electrical generators have been so far perfected as to make down-right breaking down of their functions extremely unusual. But it is not unusual for stations to be wholly or partly shut down by accidents, and fire is no unusual cause or concomitant of such occurrences. In fact, the fire risk, while enormously less than it was a few years ago, is still a consideration of much importance. It ought to be, and in fact is, no difficult matter to build a fire-proof station, but in practice fire-proof stations in any proper sense of the term are rare. As a rule, either the designing engineer is thinking of something else or somebody steps in with the blundering notion of making the station pretty and the result is a fire trap at some point. If there is any place in which the Socratic criterion of beauty should be rigidly applied, that place is an electric power station. But when it comes to fire-proof construction, somebody generally protests with serious results. Let us consider seriously the design for a station with especial reference to fire risks and see what safe construction implies. In the first place, the general shell of the plant is an easy task. Whether it be for a water power plant or a great steam-driven station, walls of stone, brick or concrete, with iron roof and floor beams, if there be more than one story, give a construction as safe from fire as anything yet devised by man. Next comes the serious question of floors. Wood which is commonly used implies a grave fire risk, particularly as it is certain sooner or later to become saturated with oil. Tile and concrete make good floors, but are not entirely free from fire risk when oil soaked.

Perhaps the best combination is as follows: For all floor not so situated as to be exposed to oil from the machinery, tile or concrete, and near and around the machinery, metal or glazed tile covered by removable grids of fire-proofed wood. It is a question to what extent fire-proofed wood can be advantageously used, but it is certainly safe enough if not used in large amounts, and there is no need of covering large areas with it. Starting with radical fire-proof construction of such sort, danger to the building as a whole is pretty well eliminated. But in station work continuity of service is of the first importance and precautions must be directed next at the apparatus so that fire shall not be able, even if in the form of an electric arc, to do damage of serious character. For convenience, we may divide the whole equipment into four parts—generators, transformers, leads and switchboard, each of which should be considered with reference to the prevention of fire risk. As to the generators, they are fairly safe except in the case of a prolonged short-circuit, and when internal damage occurs it is generally not very extensive. They are not likely to be injured seriously by external causes if the generator room floor is fairly non-combustible. In a modern large station there is often danger, more or less acute, of getting a short-circuit inside the protecting switches on the board and it is a good rule to get a safety switch cut in as near the generator as practicable. The use of revolving-field generators has greatly reduced the danger of disastrous short-circuits, and such machines form the most reliable part of the plant.

The transformers are far more exposed to danger of fire external and internal than are the generators. The discussion of Mr. Rice's excellent paper brought out the facts in the case very forcibly. The general consensus of opinion was that upon the whole oil transformers were decidedly less severe fire risk than air-blast transformers. The oil, as Mr. Townley in particular forcibly pointed out, is very far from being oil in the ordinary sense of the term. It is inflammable only with great difficulty and will put out an arc started in it under ordinary circumstances without the slightest danger of fire. It is practically merely a liquid insulator, upon the whole less inflammable and less seriously affected by heat than most solid insulators. Still it can be set on fire and then burns fiercely enough. The danger of giving off explosive vapors, to which frequent reference was made in the discussion, does not seem to us considerable owing to the very high boiling point of the oil and the density of the vapor, which makes it far from easy to get air enough for an explosion. For this reason the suggestion of oil tanks strong enough to stand 100 pounds per square inch internal pressure seems unnecessary, a relief valve in the top of a thin case appearing to us adequate protection. Provision for drainage of the oil in case of serious trouble seems highly desirable, and if the transformers be slightly raised above the floor, and the latter be sloped to drain outside the building into a sand pit no great harm can be done. It might not be a bad idea to put a plug of fusible metal in the base of the case to let out the oil into the sand pits before the flashing point could be reached, but with proper drainage the value of the oil in protecting the coils is so considerable as to make one think twice before letting it out so long as the case holds together. It makes no particular difference whether the transformers are in the generator room or a separate room, so long as oil from the transformers cannot run freely about.

Trouble with insulating the leads from the generator room to a separate transformer room must be taken into consideration. They may be, and in many stations are, a graver fire risk than the transformers themselves. They are usually of fairly high voltage and are very apt to be crowded together in a needless straining after compactness. We have a good deal of sympathy with Mr. Mershon's preference for bare conductors and his lament that our modern oil switches are so bulky to install. Oil switches are by far the best thing to use with even moderately high-voltage circuits, owing to their comparative safety in the matter of setting up surging, but they certainly are clumsy, as in fact any switch for very powerful circuits must be. In large sizes they add considerable difficulty to planning the switchboard, but they are necessary. They are, however, free from the danger of appalling leaps of the current such as are produced by air switches, and which in many plants render the switchboard by far the severest fire risk in the building. We have seen stations in which the switchboards were a constant peril both to life and to property. The commonest fault is a foolish effort at compactness, resulting in crowding the board with apparatus and incurring great risk of short-circuits or of arcs formed fierce enough to ruin the board and shut down the plant. The safest rule is to take plenty of space and to put the board where it is well lighted and fully accessible. The modern electrically or pneumatically-operated switches aid immensely in safe design, but full advantage should be taken of the facilities thus acquired for avoidance of crowding. A plant is as weak as its weakest point and a fire on the board may put it out of service for days. One of the most encouraging features of the papers and discussions under notice is the general unquestioning acceptance of these high voltages as an essential part of the modern programme, susceptible of proper engineering treatment, with a steady tendency towards improvement and the minimization of danger and damage.

A. I. E. E. International Electrical Congress Reception Committee.

The first meeting of the International Electrical Congress Reception Committee of the American Institute of Electrical Engineers was held at 12 West Thirty-first Street, N. Y., Thursday evening, March 24. A large representation of the committee was present; also Mr. George G. Ward, local honorary secretary of the Institution of Electrical Engineers, members of the board of directors, and members of the transportation committee, who had been invited to attend. Chairman Lieb proposed the following itinerary:

The foreign guests of the Institute are expected to arrive in New York previous to September 3, 1904. After that date the itinerary will be as follows:

Sunday, September 4, 1904, New York City.—This day will be spent in a steamer ride up the Hudson River, possibly as far as West Point.

Monday.—The visitors will be entertained by the corporations representing the electrical industries of New York City, including a visit to the power houses of the Rapid Transit Subway Company, the Manhattan Railway Company, the Metropolitan Street Railway Company, the New York Edison Company, the exchanges of the New York Telephone Company, and other points of engineering interest. In the evening there will be a formal reception to the foreign visitors under the auspices of the Institute.

Tuesday, Schenectady, N. Y.—The party will leave New York on Tuesday morning for Schenectady, where they will be received and entertained by the General Electric Company, leaving for Albany in the afternoon. P. M., Albany, N. Y.—Leave Albany in the evening for all-night trip to Montreal.

Wednesday and Thursday, Montreal, Canada.—Reception at McGill University, Montreal, and visits to the important power transmission plants in the vicinity, leaving Montreal Thursday evening by boat or train for Niagara Falls.

Friday, Niagara Falls, N. Y.—Visit to the Falls and the important power houses and electrical industries of the locality. Leave Niagara Falls Friday evening for Chicago, arriving Saturday morning.

Saturday, Chicago, Ill.—Visits to important power houses and local points of interest. Leave Chicago Saturday evening for St. Louis, traveling all night.

Sunday, September 11, St. Louis, Mo.—To be spent in St. Louis.

Monday.—Opening of the International Electrical Congress at 10 o'clock A.M., with joint sessions of all of the sections.

Wednesday.—Special joint session between the American Institute of Electrical Engineers and the British Institution of Electrical Engineers, to which all foreign guests are invited.

September 13, 14, 15 and 16.—Sessions of the various sections of the Congress, with sessions each day from 9 to 12 A.M., and from 1.30 to 4.30 P.M.

Saturday, September 17 (Afternoon).—Closing general sessions of all sections of the International Electrical Congress. (Night.)—Leave St. Louis for Pittsburg, arriving late Sunday afternoon.

Monday, September 19, Pittsburg, Pa.—Reception and entertainment by the Westinghouse Company, and visits to important and interesting local industries. Leave Pittsburg Monday night and arrive at Washington Tuesday morning.

Tuesday, Washington, D. C.—Inauguration of the National Bureau of Standards at Washington and visits to places of local interest.

Wednesday, Philadelphia, Pa.—Visits to important power houses and points of interest. Leave Philadelphia for Boston in the afternoon via boat—Fall River Line.

Thursday, Boston, Mass.—Visits to power houses, Harvard University, Massachusetts Institute of Technology and places of local interest. Leave Boston Thursday night for New York by boat.

Friday.—Unassigned.

Saturday, September 24.—Return home by some of the party. Ladies are expected and special arrangements will be made to insure their comfort.

The details of the tour as suggested were thoroughly discussed, and while there was a feeling that it would be a severe tax upon the visitors, it was difficult to see how the trip could be curtailed without omitting some desirable and important features. It was voted that the committee be thanked for the programme as outlined, and that it be accepted with the recommendation that if possible, the chairman of the transportation committee should arrange that there be some plan adopted by which as many sleeping cars as might be necessary would be provided for the special train on the return trip; and that such persons as desired, have the privilege of alternative return routes on regular trains. In case this cannot be arranged, the plan to be adopted as presented.

The following executive committee was appointed: John W. Lieb, Jr., chairman; F. J. Sprague, vice-chairman; J. C. Barclay, J. J. Carty, F. W. Jones, H. Ward Leonard, E. H. Mullin, L. B. Stillwell, H. G. Stott, Calvert Townley, Geo. G. Ward, J. B. White. Local committees at the various points to be visited will be subsequently announced by the chairman.

Incandescent Lamp Combination.

Note was made in these columns last week of the meetings held by the incandescent lamp manufacturers in this city and Cleveland in regard to patents, prices, policy, etc. There is not a great deal to be added to what was then outlined. Under the guidance of Mr. F. S. Terry, of the National Lamp Company, the manufacturers remained in session at the Manhattan Hotel in this city until the end of the week, when important results were reached. Some thirty infringement suits under the Malignani, Howell and Edison patents had been brought against manufacturers, jobbers and others, and these may be regarded as amongst the moving causes for the combination, although there had of late been considerable discussion on the subject also from the standpoint of ruinous rate-cutting. Be the reasons what they may, the following lamp manufacturers have now taken out licenses dating from April 1, granted by the Edison Electric Light Company and the General Electric Company, and all suits against licensees or their representatives have been discontinued. The list of licensees is as follows: Downward Light Electric Company, New York; the Sterling Electrical Manufacturing Company, Warren, Ohio; the Brilliant Electric Company, Cleveland, Ohio; the Banner Electric Company, Warren, Ohio; the Franklin Electric Manufacturing Company, Hartford, Conn.; the United States Incandescent Lamp Company, St. Louis, Mo.; the Standard Electrical Manufacturing Company, Niles, Ohio; Capital Electric Company, Denver, Colo.; Gilmore Electric Company, Boston, Mass.; Liberty Electric Company, Pittsburg, Pa.; Warren Electric & Specialty Company, Warren, Ohio; the Colonial Electric Company, Ravenna, Ohio; Shelby Electric Company, Shelby, Ohio; Bryan-Marsh Company, Marlboro, Mass.; the Buckeye Electric Company, Cleveland, Ohio; Munder Electric Company, Springfield, Mass.; Sunbeam Incandescent Lamp Company, Chicago, Ill.; Columbia Incandescent Lamp Company, St. Louis, Mo.; Independent Incandescent Lamp Company, Cleveland, Ohio; New York & Ohio Company, Warren, Ohio; Fostoria Incandescent Lamp Company, Fostoria, Ohio; General Incandescent Lamp Company, Cleveland, Ohio; National Electric Lamp Company, Cleveland, Ohio.

It will be noted that the Sawyer-Man Electric Company is not in the combination and that company has already issued a statement to the public to that effect. Four other concerns are not included, although it is intimated that some of them may still come in. It is claimed that over 99 per cent. of the lamp production of the country is represented by the capacity of the "pool" licensees. The present annual consumption of lamps is put at 45,000,000. The total productive capacity of the existing factories is placed at about 65,000,000.

With regard to concerns not yet included the statement is made that all in the business on April 1 have the option to come in on taking out a license, agreeing to the scale of prices, and consenting to pay the royalty. No information is vouchsafed as to the royalty, but it is rumored to be a gross charge of ½ cent per lamp, and an actual ¼ cent net. There is also a report that all members of the combination as licensees agree to bind themselves to sell their product at a certain flat price—say 16 cents—and not below; and it is also reported that with this and territory as a basis a certain scale is to apply to central stations, jobbers, isolated plants, etc. The question is raised as to what would be the course adopted toward a new manufacturer coming into the field after April 1 and willing to be licensed, pay the royalty and maintain rates; or, on the other hand, one who would be willing to take out a license, but objected to maintaining the proposed schedule of prices. Extremists urge that an illegal condition "in restraint of trade" might easily arise under the operation of this new license and contract. Meantime the present manufacturers appear to be very well satisfied with the close of the rate war and the protection and immunity which their license affords them. It is understood that they may form an association among themselves for the cultivation of intimacy and closer intercourse.

Steam Turbine and Other Features of the Port Huron Light and Power Company's Station.

By James E. Davidson.

THE Port Huron Light & Power Company was one of the first central station companies to contract for a Curtis steam turbine, a 1,500-kw turbo-generator having been ordered in October, 1902, which has been in operation several months. On account of the interest in the steam turbine at the present time, a description of this company's installation may not be without interest. Before going into the details of the steam turbine outfit, however, a review will be made of the general conditions in the station in which it is installed.

Port Huron is a city of about 20,000 inhabitants, situated at the southern end of Lake Huron on the St. Clair River. It is generally known to the outside world as the "Tunnel City," on account of the great international tunnel of the Grand Trunk Railway from Port Huron on the American side to Sarnia, on the Canadian side of the river. Among other industries is a shipbuilding yard, employing about 500 men. The whole yard is operated by electric motors, some sixteen in number, with current supplied by the Port Huron Light & Power Company. A traction engine and farm machine factory, together with a malleable iron factory, and a saw factory, employing 600 men, operate their plants with three-phase induction motors, ranging from 7½ to 75 hp. There are a number of other important industries, including the locomotive and car building shops of the Grand Trunk Railway. Gratiot, Huronia, La Salle and Keewahdin Beaches are large summer resorts just beyond the city limits, where many Southern people make their homes during the summer months. This company furnishes light to about 100 cottages on these beaches. Then, too, Port Huron has a very fine railway system, having cars run from one end of the city, at which point is located the principal railroad depot, on the south, to the beaches above mentioned on the north, covering a territory of about seven miles in length. During the summer months ten-minute car service is given over this territory. This is also the northern terminal of the Rapid Railway system, which runs cars hourly from Detroit, Mich. These cars are interurban type with 300 hp in motors installed under them. The Port Huron Light & Power Company furnishes power to the city railway, which operates in the neighborhood of twelve to fifteen cars per day, and also furnishes power for the Rapid Railway system in the city and about one-half mile outside of the city limits. Taken altogether, the company is covering the light and power field very fully, as can be judged from the foregoing.

The light and power business in Port Huron was started by the Excelsior Electric Company in 1885. The old plant of this company was burned twice, as a result of which experience the present station is entirely fire-proof. In June, 1901, the company was reorganized under the name of the Port Huron Light & Power Company, at which time a thirty-year franchise was obtained from the city. The

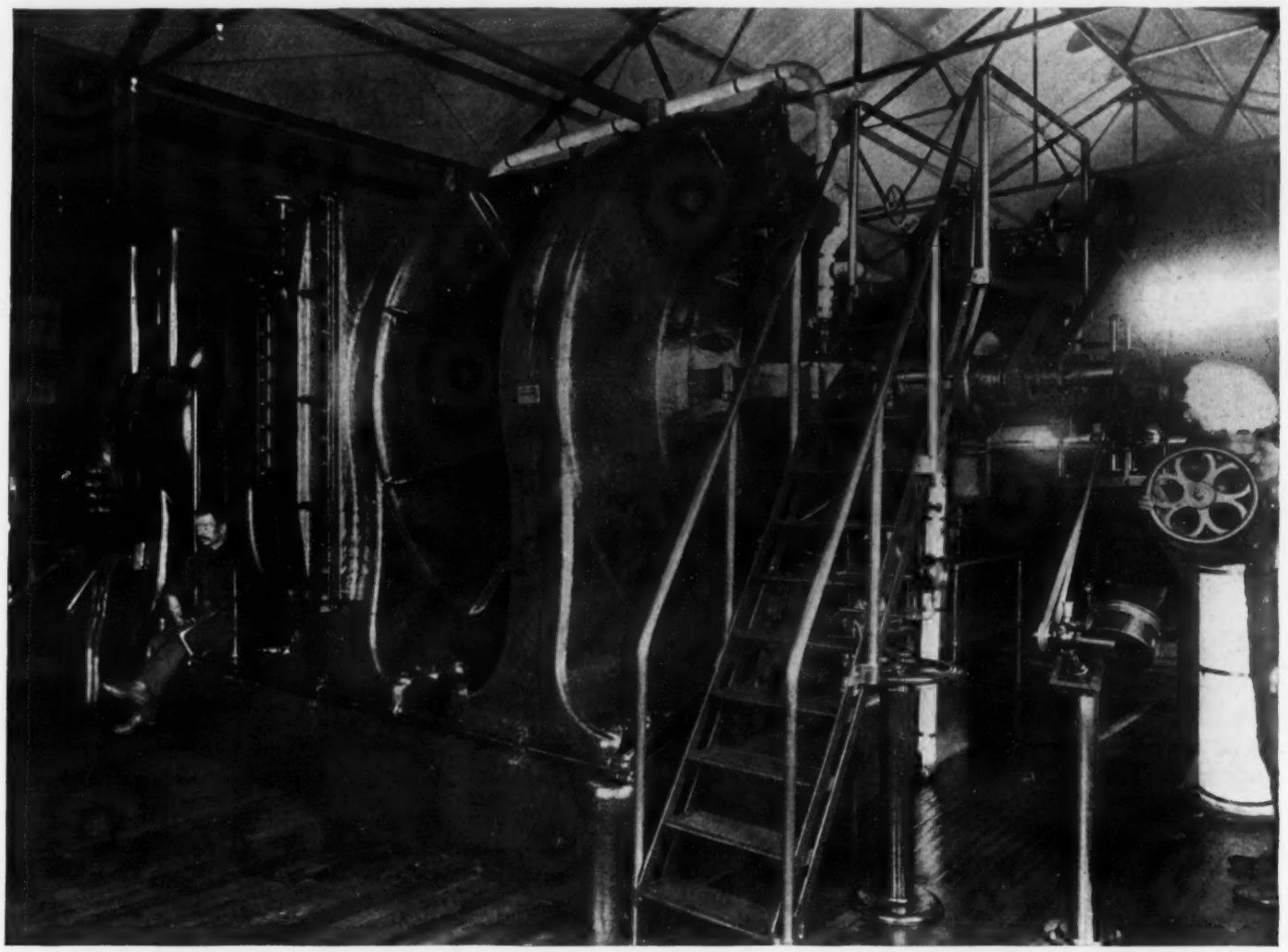


Fig. 1.—General View of Curtis Horizontal Turbine, Port Huron, Mich.

officers of the old and new companies, which have remained unchanged from the beginning are: Henry McMorran, president; Charles F. Harrington, vice-president, and W. F. Davidson, secretary and treasurer.

The property at the time of the reorganization consisted of a fireproof building 125 ft. x 138 ft., built about five years prior to this time. This building contains two compound condensing 500-hp engines, and one tandem compound condensing 1,200-hp engine; also three 500-hp and one 250-hp Stirling boilers, two Worthington feed pumps, one Cochrane heater and a Worthington jet injector. On the top of each of these boilers there are installed Crane automatic valves which close automatically in case the pressure changes in any of the different boilers. For example, if a tube is blown out, this boiler is immediately cut out from the others so there will be no interruption to the plant by other boilers losing their steam and water. The generating equipment is driven mainly by Hill's system of pulleys from line shafting, and consists partly of direct constant-current arc dynamos, partly of 500-volt railway and power gen-

erators, and partly of 60-cycle, 1,150-volt, three-phase generators. Since the 1,500-kw turbo-generator was installed, a series alternating-current arc system has been planned to do away entirely with the direct-current arc dynamos.

Direct current at 550 volts is sold for the operation of the street railway system and for commercial power within one mile radius of the plant. For factories situated some distance from the power house in a factory district called "South Park," power is transmitted at 10,000 volts, which is stepped down by transformers to 230 volts for

FIG. 2.—GENERAL VIEW OF PORT HURON PLANT.

the operation of three-phase induction motors. At different localities on the 10,000-volt transmission line are four brick transformer houses, in which the step-down transformers are installed as well as lightning arresters, and marble primary and secondary switchboards. The three-phase generators in the station are all wound for a voltage of 1,150, which is that of the primary distributing system of the general lighting and power business of the city. The lighting secondaries are 115-volt. For street lighting and commercial arc lighting, the 6.6-amp. series enclosed arc has been adopted.

To accommodate the new turbine unit, an entirely new portion of the plant adjoining the old plant was built. This is 40 x 80 ft., with a 9-ft. basement. The interior finish of this building is as follows: Maple hardwood floor, wainscotted with dark green terra vitra tile, and the rest of the side wall is finished with terra cotta pressed brick. All the machinery and iron work is painted deep blue green with vermilion and white trimmings. The machinery in the old building is also painted in the same manner. This addition is shown in the foreground in the general view of the plant, Fig. 2, and its position is shown on the plan, Fig. 3.

In adding to the plant, an ingenious plan has been worked out whereby the new turbo-generator outfit may operate both the old and new portion of the plant as long as the load is not too great. By this plan the turbo-generator operates certain three-phase generators as synchronous motors in the old plant, which motors, in turn, drive through a line shaft the necessary direct-current machinery to keep up the service. If necessary, in order to carry peak loads, or if the turbo-alternator is stopped, the engines in the old plant are started up so as to drive the line shaft and drive the synchronous motors as generators as well as the direct-current apparatus. The load can be thrown from either plant to the other without the slightest interruption to service.

The 1,500-kw turbo-generator consists of a Curtis turbine driving an alternating-current generator, the latter being a three-phase, 60-cycle, 1,150-volt machine. The unit runs at 720 r.p.m. An Alberger surface condenser guaranteed to maintain 28 in. of vacuum has been installed. This Curtis turbine unit, as can be seen from Fig. 1 and Figs. 4 to 6, is of the horizontal shaft type. The piping plant is shown in Fig. 8. Steam enters the turbine through an 8-in. pipe. The governing is accomplished at five ports, the number of ports opened depending on the load. Descriptions of the detailed construction of the Curtis turbine have appeared from time to time in these columns. There are two stages in this turbine, with four revolving discs in each stage. The bearings are sealed against air by a pocket of steam and carbon collars. To lubricate the machine, an oil pump is operated by a leather belt from a pulley on the turbine shaft between the generator and the second stage. The oil is pumped to the bearing through a 5/8-in. brass pipe and returned through a 1½-in. pipe. Before returning to the pump, the oil passes through a water cooler. This cooler consists simply of a water tank with a coil of copper pipe in it through which the oil circulates. There has not been the slightest trouble from heated bearings. The oil at the pump has a temperature of 120 to 130° F.

The turbine is equipped with a mechanical and also an electrical governor. The mechanical governor, which is the emergency governor, is set to operate a butterfly valve when the speed reaches 800 r.p.m., or 50 revolutions above normal, when the governor trips a weight which closes the butterfly valve. This emergency valve can also be operated by hand. The electric governor is the one used for the ordinary governing. The governor shaft of the electric governor is run by a 3-in. leather belt from the turbine shaft. The governor shaft runs about 200 r.p.m. and is equipped with the regular fly-ball governor. When the shaft is above normal speed, the sleeve of the fly-ball governor makes an electrical contact. When it is below speed, another electrical contact is made. Supposing that the turbine is above normal speed and the "high-speed contact" is made, a circuit is established through a magnetic clutch which con-

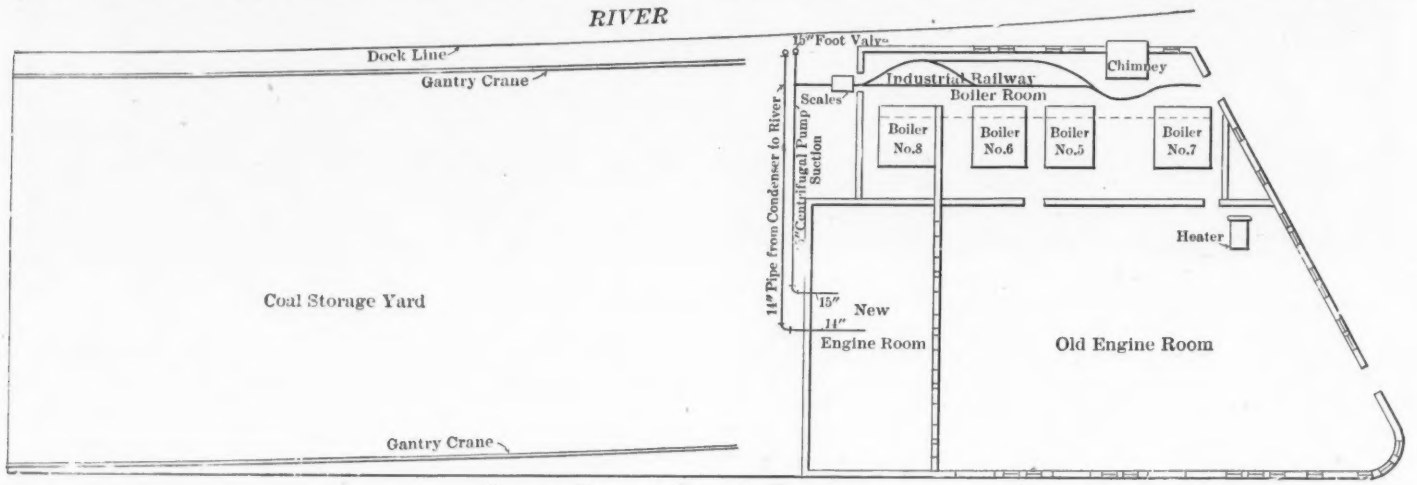


FIG. 3.—GENERAL PLAN OF BUILDINGS.

nects the governor shaft with the port valves, and which runs the governor valves down so as to close some of the row of ports. When the speed is below normal, the "low-speed contact" on the governor operates another magnetic clutch, which causes the governor shaft to operate the valves to open the ports.

This arrangement is, of course, radically different from the balanced solenoid valves very recently used on large Curtis turbine units. The steam ports open into nozzles, and closing of steam ports effects the shutting off of nozzles. There is thus no throttling action, as a nozzle is either wide open or closed, hence there is no such loss of efficiency as would occur if the steam supplying a nozzle were to

be throttled so as to lower its velocity at the nozzle. The regulation of speed with this governor with a street railway load varying from 150 to 500 kw, operated together with the other services given by the company, consisting of 500-volt power service, incandescent lighting and induction motors, is within 1.4 per cent. This excellent regulation holds its own during the heavy snow storms that they have had to contend with in their street railway work, and the turbine kept its regulation while the big interurban cars bucked heavy snowbanks, as well as the city line. At times the load would vary from zero to 1,500 amp., and the turbine would take care of this load without any perceptible change in speed. In the second stage of the turbine there are two sets of ports with governor valves instead of one set as in the first stage. The current for the operation of the governor magnets is taken from the exciter circuit.

As the high vacuum which it is considered expedient to maintain in connection with a steam turbine is a matter upon which some steam engineers have had doubts, it is interesting to note that with a load of 1,000 kw, and intake water at 72°, 28 in. of vacuum has been maintained continuously. With the same load and cooling water temperature at 58°, 28⅝ in. of vacuum has been maintained with the barometer reading 29¾ in. During the winter months the vacuum has been maintained with but very few exceptions above 29 in., and fluctuates only with the barometer. Readings within one-quarter to one-half inch of the United States Government barometer readings are obtained at all times. This, of course, is with the cooling water in the neighborhood of 40° F. By closing the valve between the condenser and the vacuum pump, a vacuum within ¼ in. of barometer pressure has been obtained. A vacuum of 28½ in. has been recorded with the exhaust from both exciting engines going into the condenser, and the vacuum pump discharging into the condenser, and with the exhaust from the circulating pump engine going into the heater. A mercury tube and not a gauge was used in all these tests.

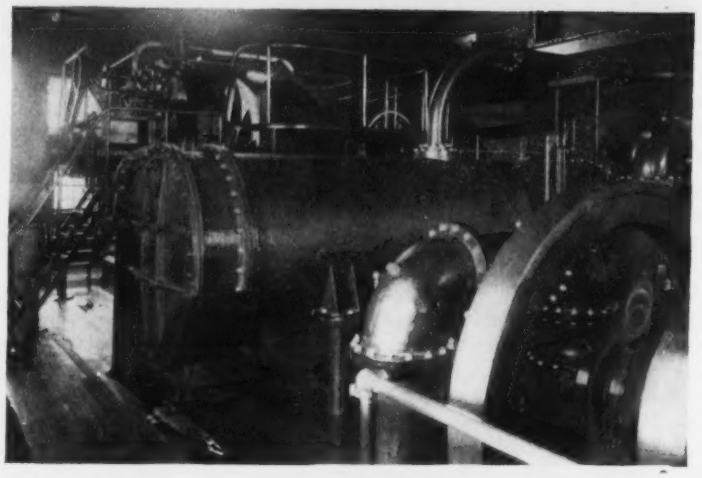


FIG. 6.—CONDENSER.

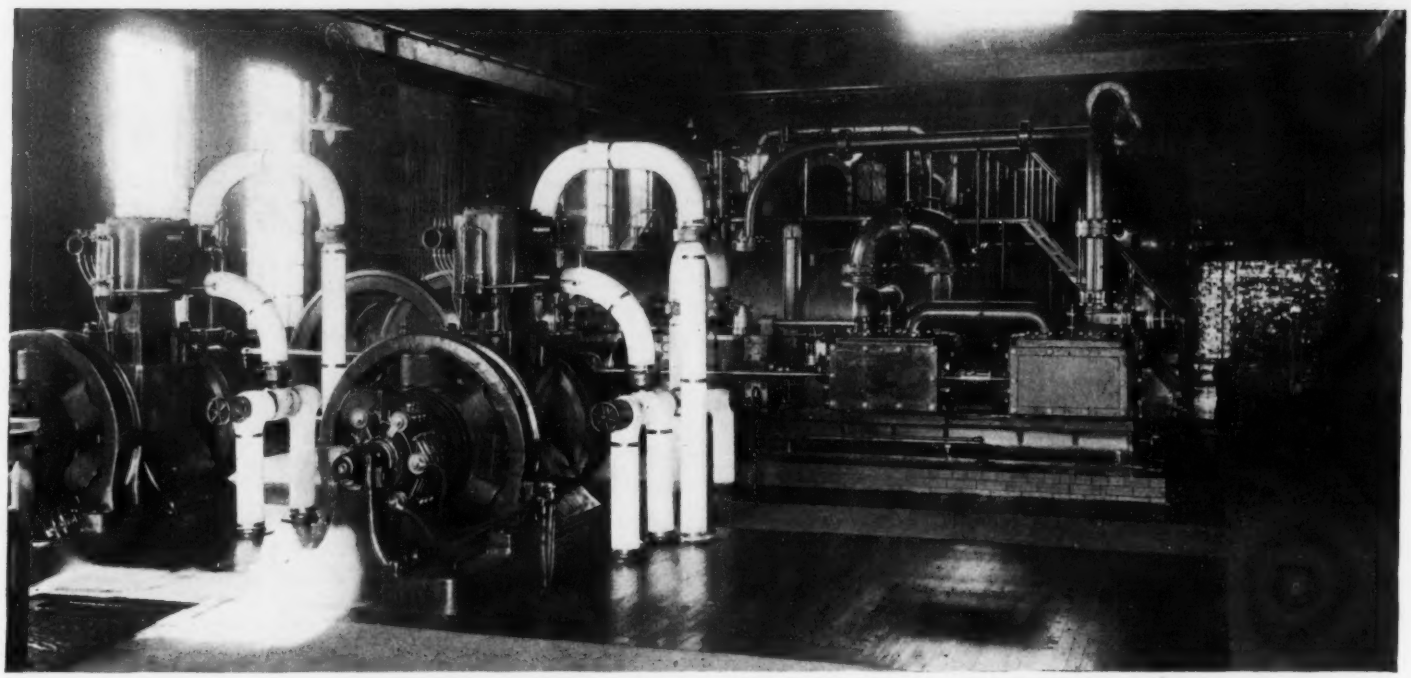


FIG. 4.—General View of Engine Room, Showing Turbine with Condenser at Rear and Exciters.

FIG. 5.—TURBINE UNIT IN PROCESS OF INSTALLATION.

The Alberger surface condenser (shown in Figs. 3 and 5) with which the turbine unit is equipped is supplied by a 15-in. centrifugal pump made by the same company. This centrifugal pump is driven by a standard Westinghouse 8½ x 8 engine direct-connected to the pump. The water is pumped from the hot well to the heater by a duplex pump. Circulating water is taken from a well open to the river. This well has cement walls 12 in. thick. The water is let in from the river through a 16-in. cast-iron pipe. The well is divided by a screen partition with ⅜-in. mesh, the inflow from the river being on one side of the screen and the suction from the circulating pump on the other side. The circulating pump suction is a 16-in. cast-iron pipe. A 16-in. free exhaust to the atmosphere is provided so that the turbine can be run non-condensing. An automatic relief

valve is provided in the turbine exhaust which automatically opens the exhaust when the vacuum is lost. The exhaust of the auxiliary engines can either be condensed or sent to the feed water heater. Condensed steam from the turbine is usd as far as it will go for feed water. The air cylinders of the vacuum pump are water jacketed. The jacket water is also run into the feed water supply, and furnishes sufficient extra feed water. The steam pressure carried on the turbine unit is 150 pounds. Standard extra heavy pipe is employed, with brass corrugated gaskets. A receiver 5 ft. long and 3 ft. in diameter, made by the Jenks Ship Building Company, which erected the piping, is placed just before the live steam pipe enters the turbine. The drip is taken from the bottom of this receiver. The steam from the boilers enters near its top and the pipe to the turbine leaves directly at the top. A Kiley standard trap is used on the receiver. Crane valves are used throughout except the throttle valve on the turbine, which is a Chapman gate valve. The six-inch air discharge on the vacuum pump is outside the building.

In the operation of the turbine there has been no trouble from the so-called end play after once setting the intermediate stationary vanes. A tachometer is located on the shaft near the throttle and is in operation all the time. Should anything happen to the governor, fair regulation can be obtained by pulling the switch to the governor and operating the valves by a hand wheel, using the indications of the tachometer as a guide. An iron platform with steps leading to it and with a brass guard rail around it, has been built so that the engineer can easily get at the governor, this being about the only part of the apparatus that needs attention, as the rest comes very near taking care of itself.

The steam pressure is reduced for the exciting engines and air pumps. The object of this is to make it possible, in cases of emergency, when the boiler pressure falls, to open a by-pass valve so as to increase the pressure on the exciter unit and keep the exciting current up to its normal value, even though the speed of the generator is decreased. The same thing can be done with the vacuum and circulating pumps so that the vacuum will not be reduced.

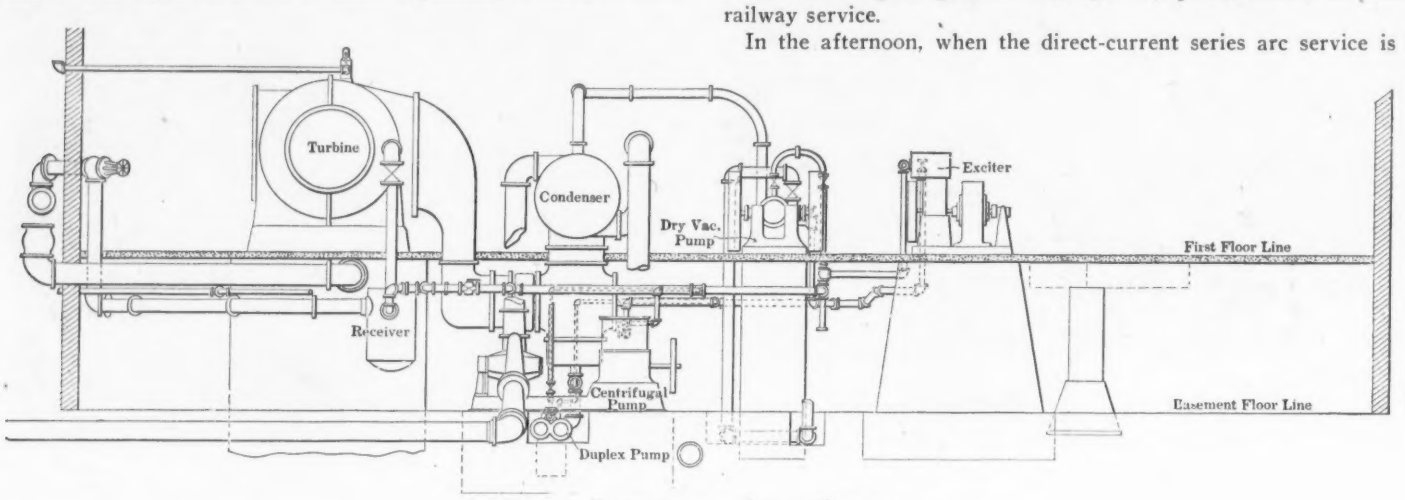


FIG. 7.—ELEVATION OF STEAM PIPING.

The expense for oil has been reduced over 50 per cent. by the running of the turbine as compared with the engines in spite of the fact that at all times three auxiliary engines are operated. As to long runs, two of the hardest months in the year, November and December, the turbine was operated almost 1,500 hours without stopping. It was then stopped to clean out the surface condenser.

Another advantage this company has noticed in its turbine over engines, and a point that has not been usually considered, is that the turbine will maintain its speed and run at one-half its capacity with steam pressure at the boilers as low as eighty pounds.

The exciter sets (seen in the foreground, Fig. 3) are two 30-kw, General Electric standard direct-connected, high-speed marine sets, giving 240 amp. at 125 volts. The engine is 11 in. x 8 in. and runs at 305 r.p.m. Either one of these is sufficient to excite all the alternators in the plant. A Tirrill regulator made by the General Electric Company, which regulates the generator voltage by interrupting the exciting current, maintains the voltage within a variation of ¼ volt in spite of the fluctuating load on the turbine. The turbine speed can be reduced to about 33 per cent. without any decrease in the voltage, as the Tirrill regulator will increase the exciting current to take care of this decrease in speed.

The turbine is operated somewhat after the following manner in every-day work: Supposing the turbine to be at rest, the condensing apparatus and exciter are put in operation. The by-pass valve around the throttle valve on the turbine is opened enough to admit live steam for warming it up for a period of about twenty minutes. At the end of that time the machine turns over slowly and in five minutes more is brought up to speed. The steam seal for the bearings is next admitted.

In the old portion of the plant a Russell engine is driving a 300-kw, alternating-current generator and three 500-volt, direct-current generators. A Ball engine is driving a 550-kw railway generator. Both engines transmit their power first to a line shaft. A switchboard attendant puts in the synchronizing plug for synchronizing the 300-kw alternator with the 1,500-kw turbo-generator. The engineer is at the throttle of the Russell engine, and an oiler is at the clutch that connects this engine with the line shaft. A Lincoln synchronizer is used to indicate when synchronism is obtained between the two alternators, and they are then thrown together. After they are thrown together a clutch connecting the Russell engine with the line shaft is opened, so that the engine can be stopped. The line shaft runs through the driven pulley of this engine in a quill. The 300-kw alternator which was a moment before running as a generator is now running as a synchronous motor driving the line shaft. That portion of the shaft being run by the Ball engine is now connected by a clutch to that portion of the shaft which is being run by the 300-kw synchronous motor. The clutch on the Ball engine is then thrown out and the Ball engine stopped. The line shaft is then being driven by the 300-kw synchronous motor, which in turn is supplied with power from the 1,500-kw turbo-alternator. The line shaft is running the generators for 500-volt power service and street railway service.

In the afternoon, when the direct-current series arc service is to be started, a 100-kw synchronous motor is started with a compensator, and this drives two Brush arc machines. A second 300-kw alternator is started by throwing in a clutch connecting the section of shaft to which it is belted to the section of shafting being driven by the 300-kw synchronous motor. The second 300-kw machine, when up to speed, is thrown in parallel with the turbo-alternator and then becomes driven also as a synchronous motor and supplies power to drive five 50-light Thomson-Houston and one Brush arc machines. The two 300-kw alternating generators or motors are located at opposite ends of the line shaft, and when they are in operation most of the line shaft can be cut out on account of the position of the driven machines near the ends. Under these conditions of operation, of course the three-phase power circuits as well as the incandescent lighting circuits are taken from the 1,500-kw turbo-alternator. The power factor of the alternator is kept up by giving the synchronous motors a leading current by heavily exciting their fields. It is easy to determine when the adjustment of the synchronous motor fields is such as to bring the power factor of the turbo-alternator close to 100. The excitation of the fields is raised gradually, and as the power factor approaches 100, the ammeter indicates less and less until, when the power factor passes 100 the ammeter needle will again rise. In other words, the synchronous motor fields are adjusted at the point which will give the lowest indications on the ammeter of the turbo-alternator.

A 325-kw motor-generator set which has been in operation two months does away with the operation of considerable line shafting

formerly used to drive 500-volt, direct-current generators. This consists of a 325-kw synchronous motor of 60 cycles driving a 550-volt, direct-current generator. By operating this set during most of the day, the line shaft can be entirely stopped, and by stopping the line shaft results have been obtained that have been astonishing; that is, in saving at the coal pile. The company never realized the power that it took to operate this line shaft.

The switchboard, Fig. 8, which is in the old portion of the plant, is mounted on an iron framework, which reaches the entire width of the building, and the floor of the switchboard gallery is on a level with the turbine room. Three sets of stairs lead to the switchboard gallery. The gallery floor is of maple. The posts on the platform are of oxidized copper, and the railing is of two-inch polished brass. The switchboard panels, twenty-one in number, are of marble. The board is 49 ft. 8 in. long with panels 90 in. high.

Beginning at the right, Fig. 8, are two direct-current, ten circuit arc panels. One of these is a positive board and the other a negative. At the left of these are two single-phase lighting circuit panels, 24 in. wide, with fuses, I. T. E. circuit-breakers and double-pole, single-throw, 300-amp., quick-break switches, controlling four circuits. The receptacles on these panels were for connecting different circuits to various machines when the generators in the station were single-

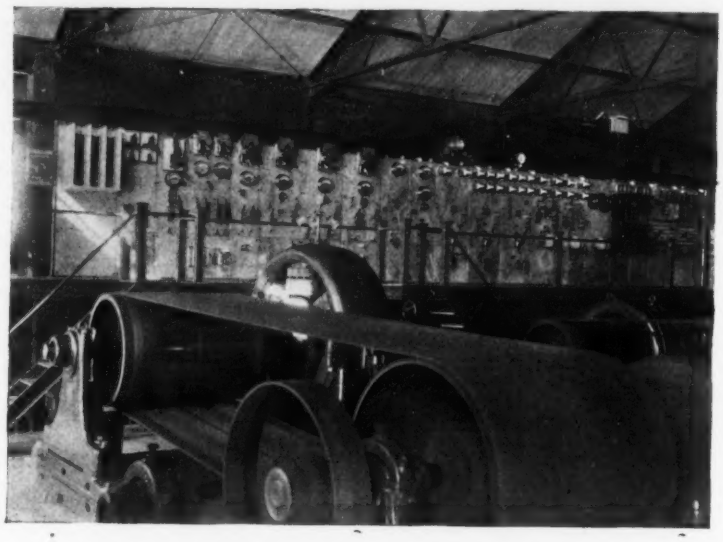


FIG. 8.—VIEW OF SWITCHBOARD.

phase and not operated in parallel. Now, all single-phase lighting is taken from one of the three phases, thus obviating the trouble from unbalancing the phases. It will be remembered that this company has a large induction motor load and that further a large per cent. of the capacity of the three-phase generator can be obtained from one of the phases.

The next panel is for controlling the secondary side of the step-up transformers. It contains one triple-pole switch and two polyphase recording wattmeters. One of these wattmeters records the energy on the high-tension transmission line to the South Park factory district, and the other measures that supplied to the 300-kw synchronous motor which drives the arc machines.

The next two panels (6th and 7th from the end) are generator panels for the 300-kw alternators, which are operated either as generators or motors. Each of these panels contains three 300-amp. horizontal edgewise ammeters, one voltmeter, 1,150-volt ground detector, synchronizing receptacle, synchronizing lamps, 200-amp., double-pole, double-throw exciter switch, and a 500-amp., 2,500-volt, three-pole, single-throw oil brake switch.

The eighth panel, which is for the 1,500-kw turbo-alternator, is 22 in. wide. On top are mounted a Lincoln synchronizer and synchronizing lamps. Mounted on the panel are three 1,500-amp. ammeters, two 1,500-kw indicating wattmeters, one 175-volt voltmeter, a synchronizing receptacle, a 200-amp., single-pole, single-throw exciter switch, one 2,500-volt, 1,200-amp., three-pole, automatic oil switch. On the sub-base is located a relay for operating the automatic device on the oil switch.

The next (9th) panel is to control the alternating-current side of the 325-kw motor-generator. It has upon it three 300-amp. ammeters, two 300-kw indicating wattmeters, one 175-volt voltmeter, a synchronizing receptacle, a 100-amp., single-throw, single-pole exciter switch, a 2,500-volt, 300-amp., three-pole automatic oil switch and one relay for the automatic oil switch. The compensators for both the 300-kw synchronous motor and 100-kw synchronous motor are located under the switchboard platform.

Next to this is the panel for operating the 100-kw synchronous motor. This has a 100-amp. ammeter, to show the primary current, one 35-amp. ammeter to show the exciting current, one 2,500-volt, 300-amp., three-pole automatic oil switch with relay. There are two panels for the exciter and each panel has an ammeter. On one is a voltmeter, which can be used on either machine with the aid of a voltmeter plug. Each exciter has two three-pole, single-throw switches. The other generator panels are for direct-current apparatus and contain the usual switches and instruments customary on 500-volt railway and power generator panels.

Recording wattmeters are placed on all outgoing light, power and railway circuits except the series arc circuits; the power supplied to the meters driving the series arc machines is measured, so that really the entire output is measured by recording wattmeters.

In connection with this plant there is a very complete system for unloading, conveying and storing coal. There is a Gantry crane operating on tracks running parallel with the dock front and spanning the coal yard.

The surface equipment for hauling coal from the coal storage to the boiler room consists of a system of industrial railway and charging cars, designed and constructed by the Russell Wheel & Foundry Company, of Detroit, Mich. The outdoor tracks are laid 18 ft. 6 in. between centers, covering the coal-storage space between the legs of the Gantry crane, and connect by means of curves and switches to a track leading to the boiler room. All cars must pass over a two-ton capacity track scale of special design.

The outer tracks, 20½ in. gauge, are made up of 16-pound rail, spiked to oak ties. The curves are of special design, 12 ft. radius to center of track, and made of cast steel. The tracks, curves and switches within the boiler room are of cast iron, cast in plates, and arranged so that the full charging cars may stand in front of the boilers and the empties may be passed around them.

The charging cars are of malleable iron and steel, of 1½ tons capacity. The running gears are so designed that the cars run around the curves of 12 ft. radius easily. The doors of the cars when lowered form an apron from which the coal is shoveled into the boilers. The ashes are removed, by means of a 12-cu. ft. tip car, to vacant property across the street.

The Gantry crane which operates on the track along the dock front is designed to unload coal from the holds of vessels and automatically convey it to a coal storage pile on the dock, the coal pile being 100 ft. wide by 250 ft. long and 20 ft. high. To accomplish this the crane spans the coal dock, running on tracks on the ground level, 110 ft. center to center, and the bottom chord of the bridge is 27 ft. clear of the dock level, giving ample clearance for a coal bucket over the coal pile.

The crane consists of a bridge with a moveable apron, a back pier that supports the end of the bridge away from the water, and a front pier carrying the hoisting and traveling mechanisms and the operator's house. Both piers are carried on wheels and a power-driven squaring shaft running across the bridge is connected by means of sprocket chains to the driving wheels on each pier.

The bridge and its hinged extension, the 35-ft. apron, carry a runway for a trolley, and supported from the trolley by means of the hoist rope is the hoist block to which is attached the coal bucket. On the front pier there is a platform upon which stands the operator's house, where controllers and levers are placed so that one operator can control all motion of hoisting, lowering, trolley traveling and bridge traveling. The hoisting and bridge traveling mechanism with its motor is also located in the operator's house. The trolley traveling mechanism with its motor is located on top of the pier, but its controller, as before stated, is below in the house. On the platform a scale is placed where the bucket can be landed so that each bucket of coal can be weighed before being stocked, if so desired. The operator's stand is so located that a clear view may be obtained of the vessel on the one hand and the stock pile on the other.

When the crane has been placed opposite a hatch from which coal is to be unloaded, the apron is lowered, giving a 35-ft. extension over the vessel's deck. The trolley carrying a clam shell bucket is run out over the hatch and the bucket is lowered into the coal. The attendant in the hold pulls the lever and gives the operator the signal. The hoist block rises, pulling on the closing chain until the bucket

jaws close together. Then the hoist block lowers and rises again, carrying with it the closed clam shell and 2,000 pounds of coal. When the trolley is reached the operator throws in his trolley traveling mechanism, running the trolley with its load back along the bridge to the dumping point, where the bucket is opened as it passes under the dumping trigger, the coal falling to the stock pile below.

About 70 per cent. of the coal in the vessel can be removed with the clam shell bucket, but the remainder must be shoveled into the ordinary coal buckets. Three of these buckets are furnished with the machine, and are dumped by the same triggers that operate the clam shell.

In rehandling the coal from the stock pile to the cars that carry it to the boiler house, the crane is used in connection with a moveable bin. This bin stands on a track of wide gauge and has a capacity of 40 tons, being sufficient to supply the power house needs for twenty-four hours. The small coal cars run under it on a narrow-gauge track and are filled by opening a valve in the bottom. In the morning the bin is filled from the stock pile with the clam shell.

In unloading the vessels the motions of hoisting and trolley traveling occur every time a bucketful of coal is handled, while movements of the entire crane are necessary only when the crane moves from a hatch that it has just emptied to a full hatch. For this reason the machine has been given a hoisting speed of 100 ft. per minute, a trolley travel speed of 600 ft. per minute, and a crane travel of only 60 ft. per minute. These speeds will enable a skilful operator to handle the buckets at the rate of one trip per minute from the hold of the vessel to the stock pile and return, and while the clam shell is in operation, only one man should be necessary in the hold of the vessel. When hand shoveling is resorted to the machine will keep three buckets in continuous operation, two of which will always be in the hold of the vessel at the disposal of the shoveling gangs. On the machine itself one man controls all the motions of the crane.

The coal yard being 250 ft. long, it is not deemed advisable to rehandle the coal into a stationary bin, as this would make the operation a slow one, and as traveling the whole crane 250 ft. to deposit one ton of coal in the bin would be too much like sending an elephant to pick up a peanut, the movable bin has, therefore, been adopted. The first work in rehandling consists in clearing up that portion of the yard nearest the river, the clam shell being used and the crane making side travels of not to exceed 30 ft. with each load. After this the crane can remain in position with the movable bin under the end near the river, and all movements can be confined to trolley traveling and hoisting, the crane being moved only when a whole section of the yard has been cleaned up. One hour's work with one man in the operator's house and one man on the coal pile

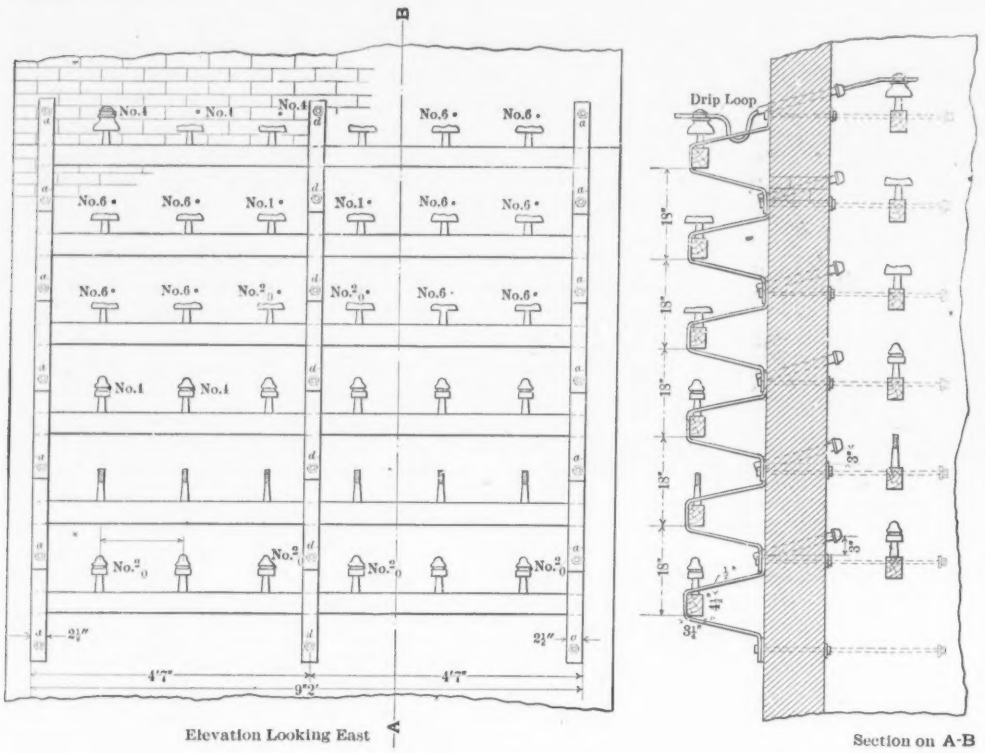


FIG. 9.—LINE DETAIL.

It will be readily seen that it would be dangerous to attempt to run a crane of this span with tracks separated by a great coal pile and nothing provided to inspire perfect alignment unless there were some provisions for automatic adjustment. If the crane were rigidly constructed, 1½ in. misalignment of the tracks would bring the flanges of the wheels against the tracks and strain the structure. Furthermore, when the crane is moved along the tracks, if one end started a little ahead of the other owing to the slipping of a wheel or the necessary lost motion in the driving chains leading from the squaring shaft to the wheels, the crane structure would again become strained and the wheel flanges bound on the tracks.

To overcome these difficulties, the crane has been built in three separate pieces; the front pier, the back pier and the bridge. At the front pier the bridge is suspended in such a manner as to allow it a limited motion in a horizontal plane about a king pin. At the back pier the bridge is allowed universal motion, this pier simply supporting the load. This form of construction permits the crane to automatically adjust itself to any reasonable track variations, and one pier can, if necessary, travel 4 ft. in advance of the other before the wheel flanges will bind. The crane is designed and built by Whitehead & Kales Iron Works, of Detroit, Mich., and is unique in being flexibly constructed and yet having but two tracks. Fig. 9 shows the arrangement of wires leaving the station.

An Important Trolley System for New Jersey.

New Jersey is the center just now of a great deal of important work in trolley extension, some of which has apparently a bearing upon other plans. Articles of incorporation for the New Jersey Short Line Railroad Company were filed last week at Trenton and deserves attention. The object of the company is to extend the electric line of the Trenton & New Brunswick Railroad Company from their present terminus at Milltown to Elizabeth. The company is a plan of the Public Service Corporation to shorten the route from Philadelphia to Jersey City by fourteen miles. It is rumored at Trenton that the line is part of the Gould system of railroads, which is trying to get to New York. The capital stock of the company is $3,000,000. The route is to cross the Raritan River, near Weston's Mills, and to go to Metuchen and Rahway and Elizabeth, where the line will connect with the present line of the Public Service Corporation.

The entire length of the road is to be fifteen and five-tenths miles, and the road is to be built in Middlesex and Union Counties. The terminus at Eliabeth will be near the western boundary of the city. The company was incorporated under the Railroad Act of 1903. The incorporators and the amount of capital subscribed as set forth in the articles of incorporation are as follows: Richard I. D. Ashbridge, of East Bowington, Pa., $19,500; Thomas S. Phillips, of Philadelphia, $19,500; Thomas B. Courley, George H. B. Martin, John H. Switzer, of Camden; Abraham A. Moyer and Thomas Heller, of Philadelphia, $200 each. The company paid to the State $37,000 as an incorporation fee.

The immediate intention of the road is to form a continuous trolley line from Philadelphia to New York, and cut off the time now lost by going from this city to Bound Brook and Plainfield to get to Newark. This road will shorten the trolley distance fourteen miles. An agreement has already been entered into between the promoters of the new company and the Public Service Corporation by which the cars of the Public Service Corporation will use the road as soon as it is built. The trolley excursion fare from Trenton to Newark is to be $1.50, and the single fare 80 cents.

Ohio Electric Light Association.

This association will hold its next annual convention at Sandusky, Ohio, on August 16, 17 and 18 next.

Booster Calculations.

By Wm. A. Del Mar.

THE booster is a generator placed in series with a conductor for the purpose of neutralizing the drop of potential in the latter. The e.m.f. of the generator is made to act in opposition to the drop in the line so as to neutralize it partially or entirely, thereby causing the combination to act as a conductor of lower resistance. If the e.m.f. of the generator were exactly equal and opposite to the drop of potential in the conductor, the two would neutralize one another, and the combination would act as a perfect conductor. It is in railway work that the booster has found its principal application. The powerful currents required in this service cause the potential of

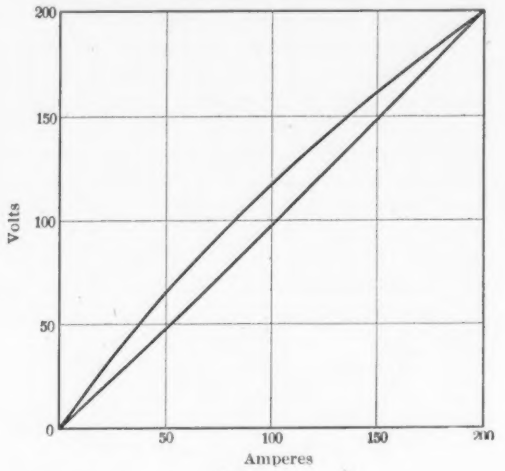


FIG. I.

feeders to fall very much at points distant from the generators. It may therefore occur that at some points the line voltage will be so low as to cause the lights to dim and the cars to run at less than their normal speed. This trouble might be remedied by the use of extra feeder cables, but it often occurs in practice that the cost of these is so enormous as to be quite prohibitive. It is in such cases that the booster finds it application. A small amount of cable and a booster will reduce the drop of potential as effectually as a system of cables that would cost perhaps several times as much.

The booster is probably most useful in reducing the potential drop

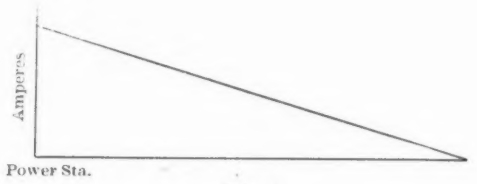


FIG. 2.

in grounded return feeders. Here a drop of potential that would not appreciably affect the operation of the car lights and motors, might be the cause of serious electrolytic damage to underground pipes and cable sheaths. This is a subject that is scarcely given the consideration it deserves, but it is gradually forcing the attention of railroad officials who have to decide whether it is better to install efficient return feeder systems or to run the chances of having to pay for the destruction of cable sheaths and pipes.

The booster is usually a series wound generator having a fairly straight characteristic, in order that its voltage may be approximately proportional to the load it carries. The characteristic of such a generator is shown in Fig. 1, with a straight line next to it for comparison. The deviation from the straight line is principally affected by the saturation of the magnetic circuit so that the smaller the allowable deviation the more expensive the generator. As, however, the curve is always above the straight line at partial loads, the booster will act better with partial than with the full load. Hence if calculations be made for the full load the booster will more than do its work at partial loads. For this reason all booster calculations should be made for full-load current. A booster may be either steam-driven if in a power station or motor-driven if in a sub-station. The method of connecting up a booster to a feeder system as well as other details, will be considered later.

In railway feeder work it is usual to assume the load to be uniformly distributed along the line, so that going towards the power station the current in the feeders gradually increases. The current flowing in the feeders to the bus-bars will thus be represented by a straight line diagram, as shown in Fig. 2. This occurs where all the feeders are connected together so as virtually to form one conductor. When, however, a booster cable is connected to the feeders

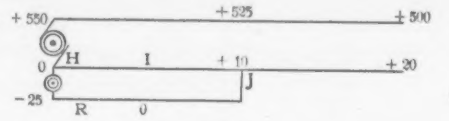


FIG. 3.

at a certain point, as shown in Fig. 3, the booster cable being insulated from the other feeders, except at that point, the current will take a course different from that shown in Fig. 2. In this case some of the current will be drawn from the line into the booster cables and the current diagram will take one of the forms shown in Fig. 4.

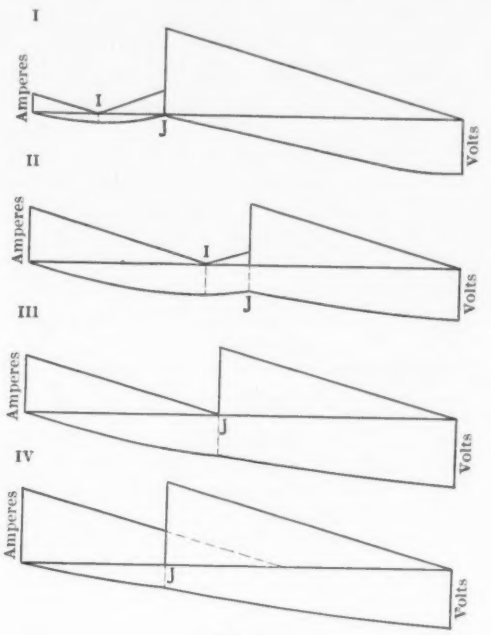


FIG. 4.

There are four typical cases to be considered, differing in the various possible distributions of current and potential Case I shows a booster which entirely neutralizes the drop in the booster cables and reduces the point of connection, *J*, to the same potential as the bus-bar. In this case current is drawn into the booster cables from both sides of the point of connection, the current dividing at a point *I* from which the resistance to the bus equals the resistance to the point *J*. In Case II, the booster only partially neutralizes the drop in its cables, but nevertheless draws current from both sides of the point of connection. Case III shows a booster drawing current only from beyond the point of connection, the whole of the current on the other side returning to the bus by the line feeders. In Case IV, the booster only draws part of the current from beyond the point of connection, the remainder returning to the bus through the line feeders with the current from between the station and that point.

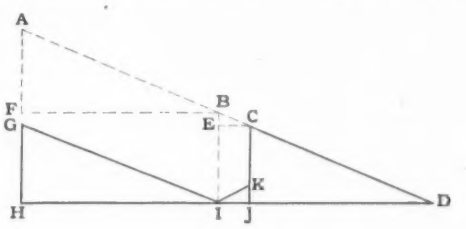


FIG. 5.

These four cases are represented with their respective curves of current and drop in Fig. 3. A fifth case might be added to these, which placed in its proper position should precede Case I. It is only useful when the permissible drop is extremely small. In this case the point of connection, *I*, is maintained at a lower potential than the negative bus itself.

The first two cases resemble one another in their current diagrams,

and may, to a certain extent, be considered together. The distribution of current in the feeder system, *H I J D* (Fig. 5), is given by *G I K C D*. The current with no booster is indicated by the broken line, *A B C D*. When, however, a booster cable is connected at *J*, it will, in the case under consideration, take all of the current from beyond it and some of the current from between it and the power station. How to determine the position of the point *I* where the current divides will be seen later. It suffices to say here that *I* and *J* being known, the current "curve" may be drawn by making *I J K* = *C E B* and *I H G* = *B F A*. A curve of drop for Case II is shown

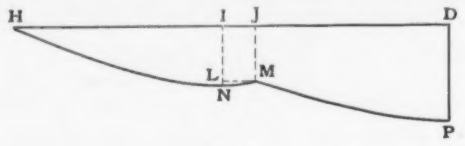


FIG. 6.

in Fig. 6, in which the letters *H I J D* refer to the same points as in Fig. 5. In this diagram the drop *I N* is due to the current *H G I*; *L N* to the current *I J K*; *M P* to the current *D J C*, and *J M* to the current in the booster cable. The drop *M P* is given for every

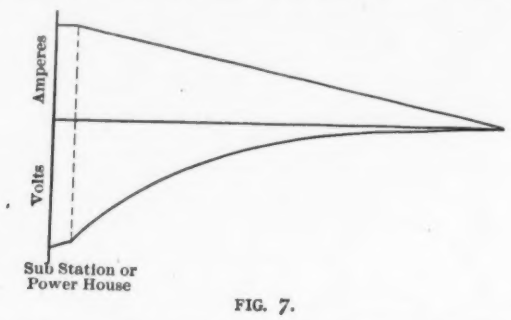


FIG. 7.

point *J*, in Fig. 7. The method of obtaining this curve is indicated in Fig. 8, in which the drop curve without booster is given by the curve *R*, and the ordinates, *R S*, are the same as the ordinates of the volt curve in Fig. 7. The drop *H N* is given in Fig. *I*; currents originating at various points, I_1, I_2, I_3, etc., and increasing the same number of amperes per foot, are assumed, and the drop from *H* to

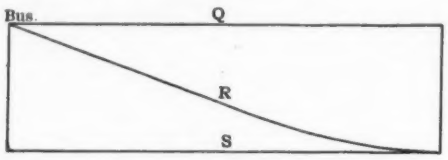


FIG. 8.

I_1, I_2, I_3, etc., are calculated and plotted as the ordinates of the curve. Thus the ordinate I_4 T_4 is the drop between *H* and I_4, with a current "curve" I_4 G_4.

A simple way to obtain the curve shown in Fig. 9 is worthy of no-

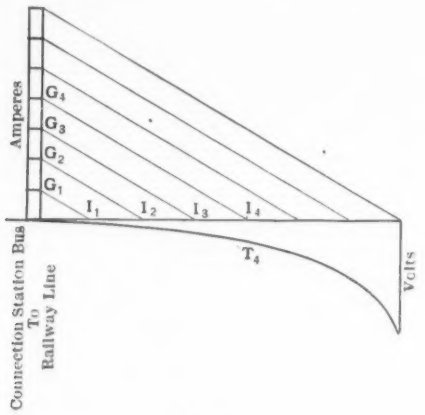


FIG. 9.

tice. Fig. 10 gives two curves of potential drop produced respectively by currents originating at *D* and *S*. It should be observed that the difference between the two currents, which is indicated by *U V*, is equal to *H T*, and that *H U* is equal to *T V*. The drop, $S V_2$, may be regarded as the sum of the drops produced by the tapering current *T V*, and the uniform current *H T*. Now *H U* = *T V*, and $S V_1$ is the drop produced by *H U*, so that $S V_2 = S V_1 + H T \times$ (resistance of *H S*) or $S V_1 = S V_2 - H T$ (resistance of *H S*).

When the curves of Figs. 7 and 9 are plotted for the line in question, it will be easy to make the calculations for a booster to give any desired drop of potential. As stated above, these curves should be constructed for the maximum current that will last for any appreciable length of time, and liberal provision should be made for an increase of load.

It is necessary to establish a formula which will give the voltage required for the booster. In any closed circuit the sum of the differences of potential taken around the whole circuit is zero. Hence, referring to Fig. 3, consider the variations of potential around the closed circuit *R J I H*, taking the drop towards the bus as positive and away from it as negative, so that if the booster voltage be represented by *V*, the following equation is obtained:

Drop in *IH* + drop in *RJ* — drop in *IJ* — *V* = *O*.

From this it follows that—

V = drop in *RJ* + drop in *IH* — drop in *IJ*.

The drops in *IH* and *IJ* are given respectively in Fig. 6, as *IN* and *LN*, so that the above formula may be written, *V* = drop in booster cables + *IN* — *LN*. Now, in Fig. 6, *JM* = *DP* — *MP* and *LN* = *IN* — *JM*, so that *LN* = *IN* — *DP* + *MP*, and, therefore, *V* = drop in booster cables + *DP* — *MP*. From the two last formulas

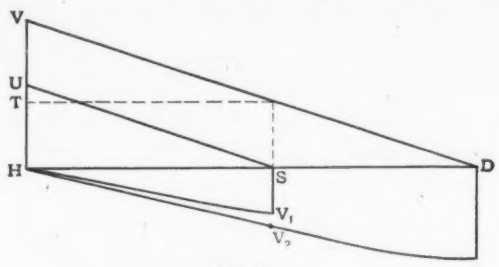


FIG. 10.

two important conclusions may be drawn, namely, that the points *I* and *J* must be so related that *LN* = *IN* + *MP* — *DP*, and that in order to get a total drop of *DP* with the booster cables connected at *J*, the booster voltage must be equal to the sum of the drop in the booster cables and the total drop *DP* in the line feeders, less the drop *MP*.

Referring to Figs. 6 and 9, it should be observed that if a certain drop *DP* be required, the point *I* cannot be farther away from the bus than the point in Fig. 9, having the ordinate equal to *DP*, and the

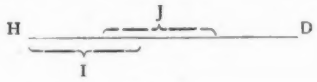


FIG. 11.

most distant location for the point *J* is midway (along the resistance —not along the length) between *I* and *D* when *I* is at its most distant position. Referring now to Figs. 6 and 7, it will be observed that *J* cannot be nearer to the bus than the point in Fig. 7, having the ordinate equal to *DP*. As *I* can be as near to the station as is desired, the possible positions of the points *I* and *J* are limited, as indicated in Fig. 11.

It is now necessary to find the most economical point *I* and its corresponding point *J* by trial. In order to find the point *J* for any point *I*, a table should be constructed on the plan given below:

1	2	3	4	5	6
Length *H J* feet.	Volts *L N* =IN (MP-DP)	Length *I J* feet	Amperes *J K*	Resistance *I J* ohms	Drop in *I J* = ½ *J K* x resist of *I J*

Different values of *H J* are chosen between the limits given in Fig.

11, and $I\ J$ being known, column 2 can be constructed. The current $J\ K$ (column 4) is the product of the amperes per foot, and the length $I\ J$ in feet. The correct value of HJ is that which causes the quantities in columns 2 and 6 to be equal. A number of points I should be tried, and their corresponding points J found according to the above directions. It is obviously wrong to choose $H\ J$ so that $IN < (MP - OP)$ as IN must have the same algebraic sign as MP and DP, and DP cannot be less than MP. Hence it is useless to assume $HJ < HI$. This narrows the limits between which to try HJ, so that very often the correct point J for a given point I will be found after three or four trials.

For any particular value of I, the cost of the booster installation is calculated in the following way. Knowing the points I and J, the currents $J\ C$ and $J\ K$ (Fig. 5) are known. The current carried by the booster cables is the sum of these. The size of cable and their number are determined by the current they carry so that their resistance and the drop in them can be calculated. The voltage of the booster is given by the formula $V =$ drop in booster cables $+$ $DP - MP$ (Fig. 6). From the current and voltage the kilowatts of the booster may be obtained. The cost of boosters is taken at a certain number of dollars (say, $75) per kilowatt, and the cost of the switchboard panel and wiring (say, $500 to $1,500) added to this.

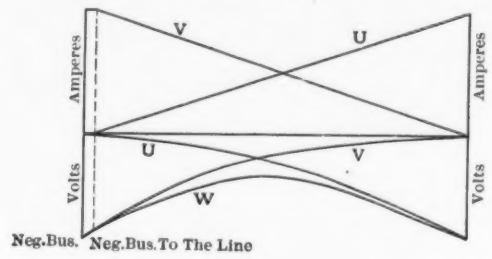


FIG. 12.

The value thus obtained added to the cost of the cable, including installation, gives the total cost of the booster system.

It is now necessary to return to some general considerations of the four cases illustrated in Fig. 4. The third case will be considered first as it is the simplest. In this case there are two completed drop curves, each of which becomes horizontal where the current is zero. Each of these curves may be derived from those given in Figs. 7 and 9. The drop from the bus to J is given by Fig. 9, and that from J to the end of the line by Fig. 7. The total drop from the bus to the end of the line, whatever the position of J may be, is the sum of the ordinates of these two curves. Fig. 12 gives the curves of Figs. 7 and 9, and one obtained by adding their ordinates. This curve W shows that Case III is not always applicable, as it fails for drops less than the minimum ordinate. For any drop greater than this minimum, there are two possible positions for the point J. An example of this is shown in Fig. 13, where the broken lines represent one case

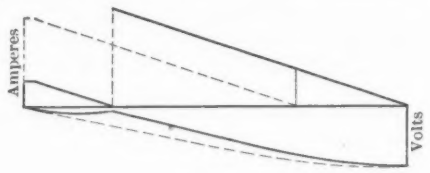


FIG. 13.

and the full lines another, each giving the same drop of potential. In Case IV, for a given position of J, the drop is greater than in Case III, because the current on the line is greater. Hence a smaller drop than is shown by the curve W (Fig. 12) is not attainable by this case.

It is now convenient to consider Case II in connection with the curve W. For a given position of J, the total drop will be a maximum when J and I are coincident, so that Case III is the limiting condition of Case II. Hence the total drop cannot exceed the ordinates of the curve W. Referring to Fig. 14, it will be seen that in order to get any given drop HQ, the point J must be chosen to the right of where QE intersects the curve V, for otherwise the drop to the end will be greater than HQ. This combined with the condition that the point J cannot be where the line QE is below the curve W, shows that J must be between A and B, or between C and E. If J be chosen in AB, the booster will have to carry a very large current, but must generate but a small voltage. This is not a practical machine, so that J will generally be in CE. When HQ is less than the minimum of the W curve, the possible positions of the point of connection, J, lie between A and E. Furthermore, the point I cannot be to the right of where QE intersects the curve U, or the drop between J and the power station will be greater than HQ. These considerations should serve to simplify the calculations by reducing the number of trials for the correct positions of I and J.

From these considerations it appears that if the desired drop be

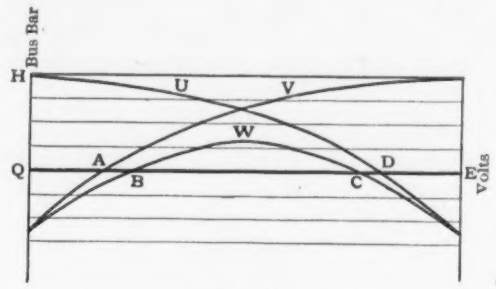


FIG. 14.

below a certain amount, Cases III and IV may be left out of consideration, and that the best way by Cases I and II must be found by trial. There are two ways of getting a given drop by Case I. One is to get the maximum permissible drop between H and J, and the other to get it between J and D.

When the cost for a number of positions of I has been calculated in the way described, a curve like that shown in Fig. 15 may be plotted, in which the total cost of the system for different positions of I or J is given. The point where the curve reaches a minimum indicates the most economical booster scheme that will give the required drop.

The apparatus required for a "negative booster" panel is shown

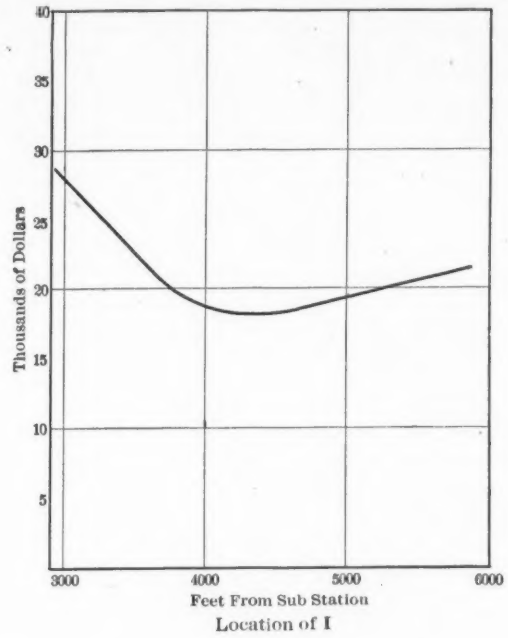


FIG. 15.

in the diagram, Fig. 16, where the booster is represented as a series dynamo driven by a three-phase induction motor. In series with this generator are a circuit breaker and switch. This switch has a single pole, but double throw, so that at times of light load the booster cables may be connected directly to the bus without requiring the use of the booster itself. In the case of a booster for the positive or non-grounded feeders, a single-pole single-throw switch is required between the bus and booster.

The following guarantees should be required of a booster. After a run of twenty-four hours at full rated amperes and volts, the temperature of no part of the machine should exceed 40 degs. C. by thermometer, above the surrounding air, provided this latter is not over 25 degs. C. The booster must also be capable of giving 25 per cent overload in amperes or 50 per cent overload in kilowatts for one-half hour, and must be able to stand a momentary overload of 100 per cent in kilowatts. The voltage regulation depends on the amount of iron in the field magnets, so that the best regulation is only at-

tainable in expensive machines. The actual voltage at any load should not differ from the voltage given by the straight line characteristic (Fig. 1), by more than 20 per cent.

In order to calculate the current that will flow through the booster cables when there is no booster, one may proceed in the following way: Let I be the total current taken by the section of line under consideration; i, the current in the booster cables; R, the resistance

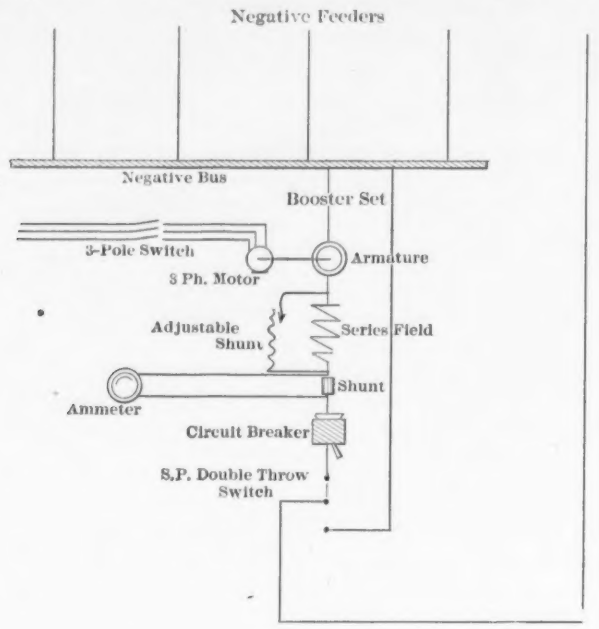


FIG. 16.

of the feeders between H and J; and r the resistance of the booster cables. Then the drop in the feeders between H and J is $R \times \frac{1}{2} (I - i)$, and the drop in the booster cables between the same points is $r - i$. These two must be equal, so that

$$ri = \tfrac{1}{2} R (I - i)$$

$$\therefore i = \frac{RI}{2r \times R}$$

This is an important calculation, as it enables the influence of the booster cables on the drop to be calculated.

In any feeder system whether or not boosters are employed, the value of the energy lost is an important item. The power lost in the line is equal to the product of the amperes per foot, and the area of

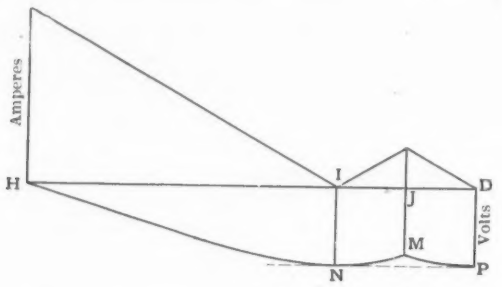


FIG. 17.—PARTICULAR CONDITION IN CASE II. THAT IS OFTEN THE MOST ECONOMICAL, NAMELY, WHEN IN = DP.

the drop curve expressed in volt feet, so that the number of watts lost in either the positive or negative system can be easily computed with the aid of a planimeter. When, however, there is a booster, the watts lost in the booster cables must be added. This may be calculated for full load and the kilowatt-hours per day obtained on this basis. In order to get the true kilowatt-hours per day this should be multiplied by the load factor. This latter quantity is obtained in the following way. As the power lost in a conductor is proportional to the square of the current in it, if the current be variable, the mean power lost will be proportional to the mean of the squares of the currents. The load factor mentioned above is the ratio of the mean of the currents squared to the maximum current squared. The mean of the currents squared may be found by squaring the ordinates of a load diagram and taking their mean.

In comparing the costs of feeder and booster systems, the value of the energy lost per annum may be capitalized and added to the initial expenditure.

When a line is supplied with current from two power houses or sub-stations, the feeder systems from these two must have about equal resistance, or one of the stations will "pull" a greater load than the

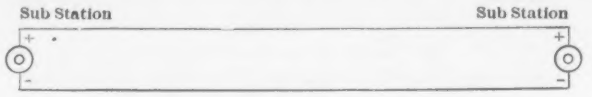


FIG. 18.

other. Hence putting a booster in one station will cause that station to carry a greater load unless the other be similarly equipped. This will not occur if the positive feeders are broken at the central point, as shown in Fig. 18. Hence there may be the choice of two booster sets against one booster set, and the cable, etc., for the break. Other problems are likely to arise in connection with booster calculations, but the foregoing considerations should be sufficient for most purposes.

High Tension Discussion in Chicago.

The Chicago branch of the American Institute of Electrical Engineers held a meeting on March 29 to discuss the general subject of high-tension work inside the station, high-tension being defined by the chairman, P. Junkersfeld, to be 5,000 volts and over.

The Institute paper of Mr. E. W. Rice, Jr., on the relative fire risk of oil and air-blast transformers was abstracted by James Lyman.

W. A. Blanck thought 30,000 volts was the upper limit of air-cooled transformers, and the lower limit for water-cooled oil transformers. Mr. Junkersfeld mentioned the awkwardness of making the connections in an oil-cooled transformer of 5,000 to 12,000 volts and large amperage. He also stated that the air-blast type is usually the cheapest, the difference depending on the temperature rise allowed. Mr. Thomas had an insulated water and oil system frozen up last winter. Mr. D. W. Roper mentioned an oil fire caused by the heat from hysteresis. Mr. G. H. Lukes thought the air diaphragm as a fire preventive both good and inexpensive. He suggested a tank of carbon dioxide on top, to smother the blaze by injection into the air duct.

The paper on the use of group switches in large plants by Mr. L. B. Stillwell was presented by Mr. F. Woodmansee. It being impracticable to discuss this in the abstract, concrete examples were suggested by various members, with the conclusion that local operating conditions entirely determine the question of installing such switches. The operation of these group switches with feeder switches under various combinations of time limits was brought up, and Mr. W. G. Carlton stated that a ground or short-circuit would shut down everything on that bus-bar before the time limit would operate if such device were used.

Oil switches for high voltages were introduced by an abstract of Mr. E. M. Hewlett's paper, and provoked a free discussion of the form of cover best adapted for oil switch boxes. Mr. Junkersfeld advocated an iron lid containing a glass panel, to reveal what the condition of the switch is after opening the switch on a short-circuit. A defective switch, if not detected before closing under such circumstances, would cause a much more serious shut-down. Mr. Sessions considered the glass unnecessary, and would so mount the iron door as to allow two inches free air space under its edges, providing the iron door with a counterweight and trip, so that it could be quickly opened.

Long Telephone Circuit.

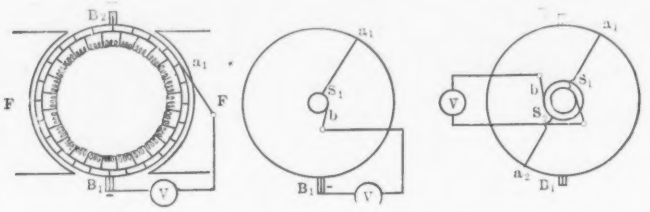
The New York Central Railroad system will soon own what it is claimed will be the longest private telephone direct wire in the world. It will be a No. 8 copper wire along the tracks of the Central all the way to Chicago. It will touch every important city on the lines of the system, and will, therefore, extend a distance exceeding 1,000 miles. West of Buffalo the wire will follow the tracks of the Lake Shore Railroad, and east of that city it will run along the New York Central tracks, coming into Weehawken along the West Shore line. The wire will cross the river in cable and will end in the Grand Central Station.

Synchronous Converters.

BY F. G. BAUM.

IT would be presumptuous for the writer to try to improve on the very excellent theory of the synchronous converter given by Mr. C. P. Steinmetz, in his book, "Elements of Electrical Engineering." However, I find that students and engineers have considerable difficulty in understanding his theory without some explanations, and I have found that the following way of approaching the subject gives good results.

If we rotate a continuous-current armature (Fig. 1.) so that we get a difference of potential between the brushes, and then connect a voltmeter to one brush and move the other terminal connected to the voltmeter around the commuator so as to get the potential of



FIGS. 1, 3 AND 4.—SINGLE-PHASE CONVERTER.

the commutator bars as they pass different parts of the field, we obtain a curve like that shown by the full line in Fig. 2.

Instead of drawing the commutator bars and winding as in Fig. 1, we shall represent the winding by the circular line as in Fig. 3.

If we connect one point of the armature winding a_1, Fig. 3, to a slide ring and connect an instrument, V, such as the oscillograph, which will measure instantaneous values of potential between the slide rings and one brush, it is evident that the curve traced will be the same as that shown in Fig. 2. That is, the potential of the slide

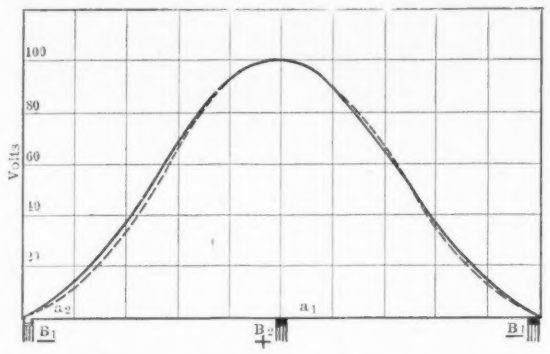


FIG. 2.—DISTRIBUTION OF POTENTIAL AROUND COMMUTATOR.

ring, counting the potential of the negative brush as zero, is measured by the ordinates in Fig. 2.

Suppose now we connect a second point, diametrically opposite to the first, to a second slide ring, S_2, Fig. 4, and connect our instruments for measuring the instantaneous potential between the two slide rings as shown. It is evident now that the difference in potential between the slide rings is the same as the difference in potential between the points a_1 and a_2, Fig. 2. But the difference in potential between a_1 and a_2 may be obtained from the curve by subtracting ordinate a_2 from a_1. In the position shown a_1 is at a higher potential than a_2. An instant before the position shown a_1 was under brush B_2, and a_2 was under brush B_1, in which position there was maximum voltage between the slide rings. This maximum voltage is, of course, equal to the potential between the brushes of the direct-current machine. As rotation goes on a_1 decreases in potential and a_2 increases, until the points are opposite the center of the pole faces, when the difference in potential becomes zero. Then a_2 increases, and a_1 decreases, until a_2 is under B_2 and a_1 under B_1, when we again have maximum voltage but the reverse of before. That is, for each revolution of the armature the potential difference between the slide rings passes through a cycle as shown in Fig. 5.

We, therefore, obtain an alternating e.m.f wave from a direct-current machine, by connecting two diametrically opposite points to two slide rings. (In a two-pole machine we connect diametrically opposite points to the slide rings; in a multipolar machine we must connect one point opposite each N pole to one ring and one point opposite each S pole to the other) to two slide rings.

We may supply direct-current to such a machine driving it as a direct-current motor, and take off alternating-current. Or we may supply alternating-current driving it as an alternating-current motor and take off direct-current. Such a machine is called a rotary converter, and is most generally used for converting from alternating to direct current. We may also drive the machine mechanically and take off alternating and direct current simultaneously.

FREQUENCY OF ALTERNATING CURRENT.

It is evident from the above explanation that the frequency of the alternating potential in a two-pole machine is equal to the revolutions per second of the armature. For an alternating current having frequency of 60 cycles the armature would have to make 60 revolutions per second, or 3,600 r.p.m. This speed is too high even for small machines, and therefore rotary converters are made multipolar. Even then it is a difficult matter to build rotary converters of large capacity

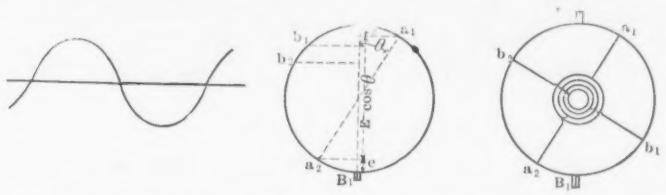


FIG. 5.—SINE WAVE OF PRESSURE. FIGS. 6 AND 7.—TWO-PHASE CONVERTER.

for as high a frequency as 60 cycles. For, as we increase the number of poles to reduce the speed, the diameter of the commutator must be increased to keep the voltage between the commutator bars within safe limits. This is a difficult matter, and, except for small capacities, rotary converters are generally not recommended for a greater frequency than 30 or 40.

If, instead of bringing taps from a_1, a_2, Fig. 4, to the collector rings, it were possible to rotate the alternating-current brushes directly on the commutator we could obtain an e.m.f of any frequency from any direct-current machine, no matter what its speed, by merely revolving the brushes at the frequency desired. To carry this out practically would mean building a commutator outside the bearing of the machine and then rotate the brushes by a small synchronous motor. It is very probable that the difficulties are insurmountable in a practical way, especially the sparking which would occur at the brushes.

WAVE FORM AND RATIO OF CONVERSION.

It is generally considered best, for general purposes, that the curve shown in Fig. 5 should be a sine wave. Now, what is the necessary condition that we get a sign wave of e.m.f. from the converter?

The maximum e.m.f. obtained is when a_1 and a_2 are directly under the direct-current brushes. Suppose the diameter of the circle in Fig. 6 represents this maximum potential, E. Then when the armature has rotated through the angle, Θ, the potential between the slide rings should be $E \cos \Theta$, which is represented by the projection of a_1 a_2 on the vertical diameter. This means that the potential difference between brush B_1 and a_2 must be represented by the projection of the arc of the circle from B_1 up to a_2 on the vertical diameter, and represented by e. Similarly, the potential between B_2 and a_1 must be e. This means, further, that the potential between any two points of the armature $b_1 b_2$ is represented by the projection of the length of the arc on the vertical diameter. The equation of the curve in Fig. 2 is

$$\text{ordinate} = \frac{E + E \cos \Theta,}{2}$$

Θ being measured from the brush B_2 as shown.

In Fig. 2 the heavy line represents the curve obtained in an ordinary direct-current machine not built for converter work. The dotted line shows the curve as it should be to give a true sine wave. As we see, the curves differ very little, and it is generally found that any armature completely overwound gives a close approximation to a sine wave, with the ordinary design of pole pieces. However we find occasionally machines with distorted waves, and it is difficult to operate these as synchronous converters, owing to "hunting," caused by a difference in wave between generator and converter.

With two diametrically opposite points we obtain practically a sine wave from any direct-current machine; but it is easy to see that if we connect two points very near together to two slide rings we will not obtain a sine wave, unless the potential of distribution around the

commutator is as shown by the dotted line in Fig. 2. With two points very close together we would obtain from an ordinary direct-current machine the curve of magnetic distribution, since owing to the small and equal air gap the angularity of the coil may be neglected. We will therefore not get the same e.m.f. curve from a three-phase converter as from a single-phase, because for the three-phase the armature is tapped every 120° instead of 180°, as in the single-phase or two-phase.

We may obtain a two-phase converter by tapping the armature as in Fig. 7, the phase b_1b_2 being taken midway between a_1a_2. A three-phase converter may be obtained by tapping the armature as in Fig. 8.

RATIO OF ELECTROMOTIVE FORCES.

Since in a single-phase or two-phase converter the maximum alternating-current potential is equal to the direct-current brush potential, the effective value of the alternating e.m.f., assuming a sine wave, is

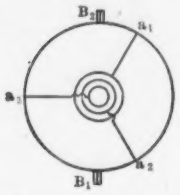


FIG. 8.—THREE-PHASE CONVERTER.

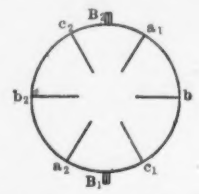


FIG. 9.—SIX-PHASE DIAMETRICAL CONNECTION.

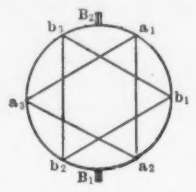


FIG. 10.—SIX-PHASE DELTA.

$$E_1 = E/\sqrt{2} = .707\ E. \qquad (1)$$

In a three-phase converter the maximum potential between a_1 and a_2 would be when the arc, a_1a_2, has a maximum projection on the diameter, B_1B_2. This length will be the length of the cord a_1a_2. This may be easily found as follows: The length of the radius of the circle, Oa_1, is $E/2$, and the length of the cord, a_1a_2, is therefore $\frac{E\sqrt{3}}{2}$. The effective value of the potential is

$$E_1 = \frac{E\sqrt{3}}{2\sqrt{2}} = .615\ E. \qquad (2)$$

The only other converter used to any practical extent is the six-phase converter. This may be obtained by tapping the armature at six points as shown in Fig. 9. Evidently we may connect one phase across the diameter as shown in Fig. 9 or across 120° as in Fig. 10. The first is the diametrical connection which has the advantage of a higher voltage between slide rings over the "delta" ( ) shown in Fig. 10.

FIG. 10. SIX-PHASE, DELTA CONNECTION.

If there are n collector rings the voltage between adjacent collector rings will be

$$E_1 = \frac{E \sin \pi/n}{\sqrt{2}}, \qquad (3)$$

as may be easily proved.

RATIO OF CURRENTS.

Consider again the converter as transforming from direct to alternating. Suppose I amperes direct current is consumed by the converter, what will be the output in alternating current? Take first a single-phase converter. Since for a complete cycle the direct-current input must be equal to the alternating output, neglecting losses, we must have, assuming the alternating current to be in phase with the pressure,

$$EI = E_1I_1 \qquad (4)$$

in which E_1 and I_1 are the effective values of alternating pressure and current. But we have $E_1 = E/\sqrt{2}$; substituting above we obtain

$$I_1 = I\sqrt{2}$$

That is, the effective value of the alternating current is the $\sqrt{2}$ times the direct current. Now the maximum value of the alternating current is $\sqrt{2}$ times the effective, and hence the maximum value of alternating current

$$I_1\ max = 2I \qquad (5)$$

Hence, in a single-phase converter the maximum value of alternating current is twice the direct current. At the instant then when the alternating current is a maximum, that is, when points a_1a_2 pass under the direct-current brushes, twice as much power is given out on the alternating side as comes in on the direct. When, on the other hand, the alternating current is zero, power is being taken from the direct-current mains at the same constant rate as before.

Referring to Fig. 6, when a_1a_2 are in the position shown the alternating-current pressure is $E \cos \Theta$, and if the current is in phase with the pressure, its value is $2I \cos \Theta$. The instantaneous power going out on the alternating side then $2EI \cos^2 \Theta$. The instantaneous direct-current power taken by the armature is EI. The difference between these must be the power given to or taken from the armature.

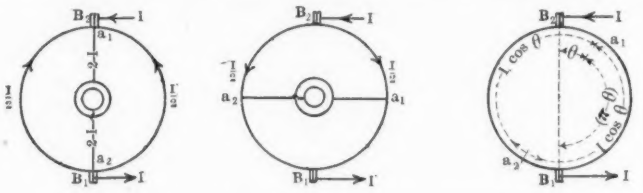
$$\text{Power given to armature} = 2EI \cos^2\Theta - EI$$
$$= EI\ (2\cos^2\Theta - 1) = EI \cos 2\Theta \qquad (6)$$

In a single-phase converter, therefore, when a_1a_2 pass under the brushes, a direct current, I, flows to the converter but an alternating current, $2I$, flows to the collector ring (Fig. 11). We may regard the direct current, I, as flowing direct from the direct-current mains to the alternating slide rings without going into the armature. The source of the other current, I, necessary to make up the difference between the alternating and the direct-current is, in this position, the armature, the inertia of the armature supplying the power, EI. When a_1a_2 have moved through 90 degrees to the position shown in Fig. 12 the alternating current is zero, but the direct current is still I. The direct current, I, flows then from brush to brush, giving back the power, EI, to the armature rotating mass. In a single-phase converter then the armature acts alternately as a motor and as a generator twice per cycle. As we shall see, because of this fact the single-phase converter does not commutate as well as the polyphase converter, in which the flow of power to and from the converter is at every instant the same, neglecting "hunting" and losses.

In a two-phase converter the power, EI, is flowing to the armature from the direct-current mains. The outgoing energy on the alternating side for a complete cycle must equal the incoming energy for the same time. Since we have two phases we have

$$EI = 2E_1I_1 \qquad (7)$$
$$\text{But } E_1 = E/\sqrt{2}$$
$$\text{Therefore } I_1 = I/\sqrt{2} \text{ or}$$
$$I_1\ max = I \qquad (8)$$

That is, the maximum value of the alternating current is equal to the direct current. Here we see that in a two-phase converter when a_1a_2 are directly under the brushes all the incoming direct current flows



FIGS. 11, 12 AND 13.—RATIO OF CURRENTS.

directly to the alternating slide ring, and there is no current in the armature (this assumes no losses). When b_1b_2 are on the brushes the same thing will occur in the direct-current passing direct to the slide ring without entering the armature.

We can easily see from the above that there will be less heating in a two-phase converter than a single-phase, because four times per revolution the armature current is zero—that is, the direct current passes directly from the direct-current mains to the alternating-current circuit without going through the armature—and for a considerable time the armature current is nearly zero. In a six-phase converter, diametrically connected there will be no armature current six times per revolution. In a three-phase converter three times per revolution the current flows over only a part of the armature.

HEATING OF ROTARY CONVERTERS.

With the above as an introduction, to give some idea of what occurs, let us calculate in as simple a manner as possible the heating of a single-phase and a two-phase converter. First, consider a single-phase converter, Fig. 13. It is simpler here to consider the direct current flowing from brush to brush just as though it were a direct-current machine, a current, $I/2$, flowing down each side of the armature. The

alternating current, $2I \cos \Theta$, flows from a_2 to a_1, $I \cos \Theta$ flowing over each half of the armature, as shown in Fig. 13. We need only consider the heating of one side of the armature from brush to brush, as the other side will be the same.

The actual value of the current in that part of the armature between B_2 and a_1 will be the sum of the alternating and direct current; that is, equal to $I/2 + I \cos \Theta$; and the current in that part of the armature between a_1 and b_1 will be the difference between the alternating and direct current, and hence, equal to $I/2 - I \cos \Theta$. The resistance between B_2 and a_1 is proportional to Θ, and the resistance between a_1 and B_1 is proportional to $(\pi - \Theta)$. The instantaneous heating in the position shown is therefore proportional to

Instantaneous heating $= (I/2 + I \cos \Theta)^2 \Theta + (I/2 - I \cos \Theta)^2 (\pi - \Theta)$.

$= (I/2)^2 [(1 + 2 \cos \Theta)^2 \Theta + (1 - 2 \cos \Theta)^2 (\pi - \Theta)]$

$= (I/2)^2 [\pi + 8 \Theta \cos \Theta + 4\pi \cos^2 \Theta - 4\pi \cos \Theta]$,

and the average heating is the average value of this between the limits of Θ and π.

Average heating

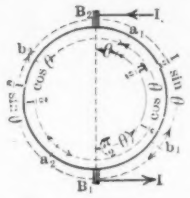
$$\frac{I}{\pi} (I/2)^2 \int_0^{\pi} (\pi + 8 \Theta \cos \Theta + 4 \pi \cos^2 \Theta - 4 \pi \cos \Theta) \, d \Theta$$

$$= \frac{(I 2)^2 (\pi^2 + 2\pi^2 - 16)}{\pi}$$

$$= (I/2)^2 \pi (3 - 16/\pi)^2 = (I/2)^2 \pi (1.37) \qquad (9)$$

The factor π comes in because the resistance of one side of the armature has been assumed to be equal to π.

If this machine were acting as a direct-current generator, delivering the current, I, the heating of each side of the armature would be proportional to $(I/2)^2 \pi$, and hence we see that the I^2R loss in the single-phase converter is 37 per cent. greater for the same output than the same machine as a direct-current generator. To give the same heating the output of the rotary must be decreased. The rating of a



FIGS. 14 AND 15.—RATIOS OF CURRENTS.

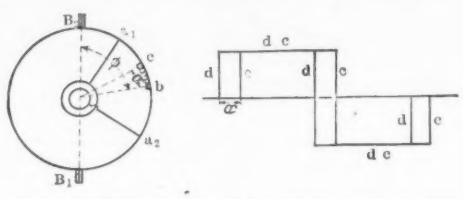


FIG. 16.—RECTANGULAR CURRENTS IN COILS D & C.

direct-current machine must be $1/\sqrt{1.37} = .85$ x rating as direct-current generator, for the same heating.

In the two-phase converter, Fig. 14, we must consider the current in three parts of the armature. These currents are as follows:

Current between B_2 and $a_1 = I/2 (1 + \cos \Theta - \sin \Theta)$

Current between a_1 and $b_1 = I/2 (1 - \cos \Theta - \sin \Theta)$

Current between b_1 and $B_1 = I/2 (1 - \cos \Theta + \sin \Theta)$

To get the average heating we integrate between the limits of O and $\pi/2$, because from $\Theta = 0$ to $\Theta = \pi/2$ the armature current passes through all possible values. We get, then, by proceeding as before,

Average heating

$$= 2/\pi (I/2)^2 \int_0^{\pi/2} (2\pi + 4 \Theta \cos \Theta - 2 \pi \cos \Theta - 4 \Theta \sin \Theta) \, d \Theta$$

$$= (I/2)^2 \pi (2 - 16/\pi^2) = (I/2)^2 \pi (.37) \qquad (10)$$

Here we see that the heating of a two-phase converter is only 37 per cent. of that of a direct-current generator for the same output. In order to get the same heating the output may be increased to $1/\sqrt{.37} = 1.64$ times output of direct-current machine. The capacity of the two-phase converters is $\frac{1.64}{.85} = 1.93$ times that of the single-phase.

While the above method gives us a good insight into the real reason for the decreased heating of polyphase converters it becomes laborious to work out each case separately. A general method due to Mr. Steinmetz will now be given. No clearer piece of mathematical reasoning has ever been given.

In a converter having n collector rings tapping the armature at n equal spaces around the commutator the voltage between adjacent collector rings will be:

$$E' = \frac{E \sin (\pi/n)}{\sqrt{2}} \qquad 3(b)$$

(In a single-phase converter $n = 2$, in a two-phase converter $n = 4$, etc.)

The current between two collector rings may be obtained by the equation (assuming no lag of alternating current):

$$n E' I' = E I \qquad (11)$$

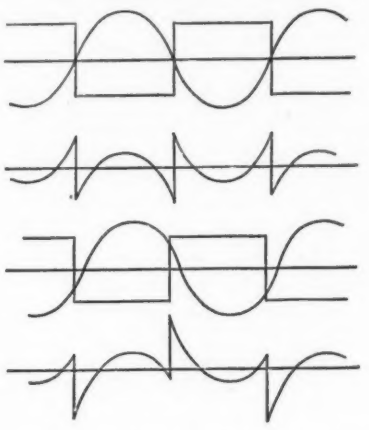
By substituting the value of E' we obtain

$$I' = \frac{I\sqrt{2}}{n \sin \pi/n} \qquad (12)$$

Now consider a coil, c, of the armature at an angular distance α from the position midway between two adjacent collector rings, as in Fig. 15. The alternating e.m.f., and therefore the current between $a_1 a_2$ will reach a maximum value when the angle ϕ is 90°. Now it is evident that the direct current in every armature coil reverses when the coil passes under brush B_1 or B_2. The alternating current, however, in any armature coil between a_1 and a_2 is the same. If we plot the rectangular direct current in the coil, d, counting time when the coil passes from one side of the brush to the other we obtain the curve, d, shown in Fig. 16. In successive armature coils the rectangular currents are displaced in phase. That is, for example, the current in the coil c is as shown by the curve, c, in Fig. 16. The alternating current being the same throughout the section between a_1 and a_2 the direct and alternating currents are thrown more and more out of phase as we pass from d to a_1 or a_2, as shown in Figs. 17, 18, 19 and 20. At the alternating leads, a_1 and a_2, the alternating and direct currents are out of phase by the angle π/n.

FIGS. 17, 18, 19 AND 20.

The direct current, then, in the coil, c, is $I/2$ for half a period; that is, from the time the coil passes from B_2 to B_1. The current in coil d is $\sqrt{2}I' \sin \phi$, I' being taken from equation (12). The alter-



FIGS. 17, 18, 19 AND 20.—PHASE RELATIONS.

nating current in coil c is $\sqrt{2} I' \sin (\phi - \alpha)$. By substituting the value of I' from equation (12) we obtain

$$\text{Alternating current} = \frac{2I \sin (\phi - \alpha)}{n \sin \pi/n} \qquad (13)$$

The actual current in the armature coil, c, is the difference between the alternating and direct current, and is therefore equal to

$$i_0 = \frac{2I \sin (\phi - \alpha) - I/2}{n \sin \pi/n}$$

$$= I/2 \left[\frac{(4 \sin (\phi - \alpha)}{n \sin \pi/n.} - 1 \right]$$

The effective value of this current is

$$I_0 = \sqrt{1/\pi \int_o^\pi i_0^2 d\varphi} = I/2 \sqrt{1/\pi \int_o^\pi \frac{(4 \sin(\phi - a) - 1)\, d\phi}{n \sin \pi/n}}$$

$$= I/2 \sqrt{\frac{8}{n^2 \sin^2 \pi/n} + 1 - \frac{10 \cos a}{n \pi \sin \pi/n}} \qquad (14)$$

$I/2$ is the armature current of a direct-current generator, and hence for the same output the ratio of the heating of the coil, c, of the converter to the heating when used as a direct-current generator is

$$Y a = \left(\frac{I_0}{I/2}\right)^2 = \frac{8}{n^2 \sin^2 \pi/n} + 1 - \frac{16 \cos a}{n \pi \sin \pi/n} \qquad (15)$$

This ratio is a maximum at the alternating leads a_1 and a_2, where $a = \pi/n$, and is a minimum for the coil, d, midway between a_1 and a_2. The value of Ym and Yo, the maximum and minimum values of $Y a$ may be obtained from equation (15) by substituting $a = O$ and $a = \pi/n$.

The average heating of the armature is obtained by integrating $Y a$ over the width of the coil between a_1 and a_2. Doing this we obtain

$$\text{Average heating} = Y a = n/\pi \int_o^{\pi/n} Y a \, d a$$

$$= \frac{8}{n^2 \sin^2 \pi/n} + 1 - 16/\pi^2 \qquad (16)$$

By substituting $n = 2$ and $n = 4$ we verify equations (9) and (10). The rating of the converter will be

$$\text{Rating} = 1/\sqrt{Ya} \qquad (17)$$

The following table, given by Steinmetz, may be worked out by substituting different values of n:

Type.	Dir.-Cur. Gen.	Single Phase.	3 Phase.	4 Phase.	6 Phase.	12 Phase.	∞ Phase.
n		2	3	4	6	12	
Yo	1.00	.45	.225	.20	.19	.187	.187
Ym	1.00	3.00	1.20	.73	.42	.24	
Ya	1.00	1.37	.555	.37	.26	.20	
Rating (by mean arm. heating)	1.00	.85	1.34	1.64	1.96	2.24	2.31

For tables of capacities taking into account mechanical losses or wattless currents the reader is referred to Steinmetz's "Elements of Electrical Engineering."

ARMATURE REACTION.

Consider the single-phase converter. The direct current may be considered as flowing down each side of the armature from brush to brush as though the alternating current were not present. With the brushes in the neutral position this would give us a magnetomotive force which may be represented by the line $s\ o$, Fig. 21, the point o being the centre of the larger circle. When a_1 and a_2 are directly under the brushes; the alternating current is double the direct current, but opposite in direction. The M.M.F. of the

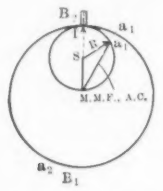


FIG. 21.—ARMATURE REACTION OF SINGLE-PHASE CONVERTER.

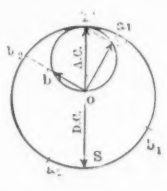


FIG. 22.—ARMATURE REACTION. OF TWO-PHASE CONVERTER.

alternating current when a_1 and a_2 are under the brushes will then be represented in magnitude and direction by $O\ T$, the diameter of the small circle in Fig. 21. This gives the resultant M.M.F. of $s\ T$.

When a_1a_2 have moved to the position shown in Fig. 21, the M.M.F. of the alternating current will be represented by the line $o\ a'$. The locus of the alternating M.M.F. may be easily seen to be the circle $o\ T\ a'$. In whatever position the alternating leads are, the resultant M.M.F. of direct and alternating current gives a vector of constant magnitude and the direction is the line giving the two alternating-current taps (this in a two-pole machine) $s\ T$. $s\ T$ is a vector rotating with twice the frequency of the alternating current. The armature reaction of a single-phase converter, therefore, passes from a generator reaction to a motor reaction twice the revolution. On account of this the commutation of the direct-current converter is not as good as that of the polyphase converter.

In the polyphase converter the armature reaction is practically absent, as may be easily shown. The demonstration will be given for a two-phase converter.

In Fig. 22 the line $o\ s$ represents the direct-current M.M.F. (for the same current intake $o\ s$, Fig. 22, and $s\ o$, Fig 21, will be the same

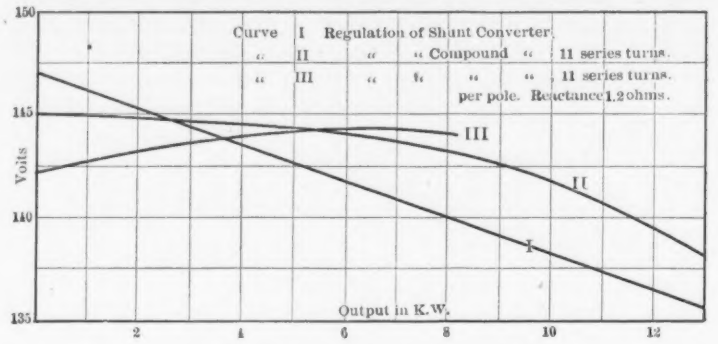


FIG. 23.—REGULATION OF CONVERTER.

magnitude, but to give a simple result in each case a different scale is taken). The M.M.F. of phase a_1a_2 will be again $o\ a'$, and the M.M.F. of phase b_1b_2 will be ob'. The resultant of oa' and ob' gives the length $o\ T$, which is equal and opposite to the M.M.F. of the direct current. Hence the alternating and direct current M.M.F. are balanced, giving little reaction for a balanced polyphase converter.

COMPOUNDING OF CONVERTER.

At constant impressed alternating potential the direct current voltage will be practically constant also. Varying the field excitation of the converter will not materially affect the ratio of conversion. The regulation of a converter is better than that of a direct-current, shunt-wound generator on account of the absence of armature reaction. In Fig. 23, curve I shows the regulation of a shunt-wound converter, and curve, II, the regulation when the converter was compounded with 11 turns per pole. The only way to compound the rotary is to automatically vary the pressure at the alternating-terminals. This can be done by introducing reactances into the line and then compound-winding the rotary, so that as the load comes on the rotary the leading alternating current drawn by the machine will cause a rise in pressure through the reactance. This problem then is the same as that of compounding a synchronous motor[1] so the changes of load will affect the pressure at the machine terminals in a desired way. Curve III, Fig. 23, gives the regulation of a converter with external reactances.

Trolley to Haul Logs.

It is stated from Bangor, Maine, that a trolley system is in successful operation in the Maine woods, hauling heavy loads of logs. It is the invention of A. O. Lombard, of Waterville, and is somewhat like the flat construction cars used on street railways. It is twenty feet long and six feet wide, and its wheels, like those of the steam hauler, run on an endless lag bed, supported on roller bearings, while the framework of the bed is so constructed that the machine accommodates itself to all knolls and other irregularities in the road. The cog gears which do the driving are so constructed that no matter what the position of the machine they always turn within each other. The machine is fitted with two twenty-five horse-power motors and a Westinghouse controller, and is geared to run about four miles an hour. Over the axle of the machine a rocker is pivoted, and on this is rested one end of the load of logs to be hauled, the rear end of the load being supported by a common logging sled. Other sled loads of logs may be attached in tow. The hauling capacity of the machine has been tested as high as 58,280 ft. at a trip.

The electric machine runs over a road seven miles long, the usual trolley system being used, current being generated at a water power plant with steam reserve. Illuminating current is also supplied by the plant, and the logging roads and landings are brilliantly lighted with electricity.

[1] Synchronous Motor Calculations, by F. G. Baum, ELECTRICAL WORLD AND ENGINEER. May 17, 1902.

The Telephone Substation.—III.

By Arthur V. Abbott, C.E.

The mounting of an induction coil usually depends on the place where it is to be used. Coils which accompany a wall or cabinet set are merely wound on a spool and placed in a chamber made by expanding the base of the transmitter arm, as illustrated in Fig. 14. For switchboards and desk sets when the coil is to be attached to neighboring woodwork it is usually mounted on a wooden base, *a*, as in Figs. 10, 12 and 13. Fig. 15 is from a photograph of the group of coil dissected to form Table 5.

As an aid in designing the winding of induction and other coils Table 6 is appended, collected from experimental data gained in the winding of many coils with various kinds of insulation.

Owing to the scarcity of data upon induction coil construction, the design of a new coil is more or less a matter of experiment, and for this purpose it is well after roughly designing the windings to construct experimental coils which shall enable the design to be tested.

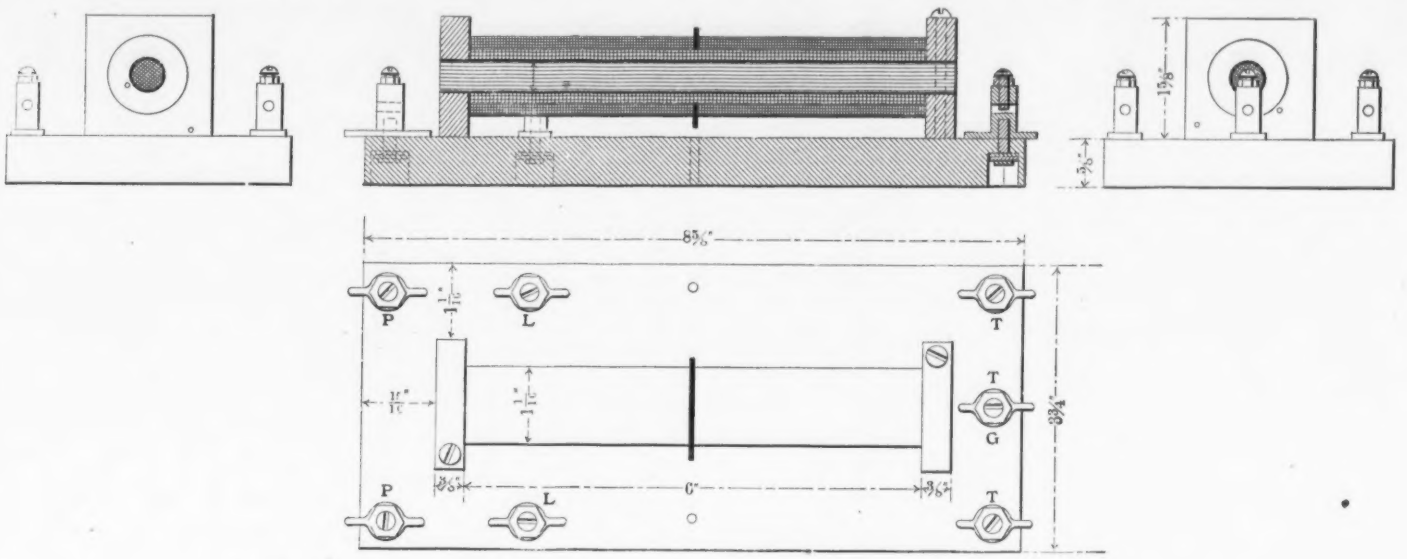


Fig. 10.—Induction Coil for Operator's Switchboard Transmitter, Local Battery.

TABLE VI.—DATA FOR WINDING COILS.

Size of wire: B. & S.	Resistance Ohms per Cubic Inch.				Inches per Turn or Layer.				Feet of Wire per Cubic Inch.			
	Single cotton.	Double cotton.	Single silk.	Double silk.	Single cotton.	Double cotton.	Single silk.	Double silk.	Single cotton.	Double cotton.	Single silk.	Double silk.
0000	.0000111	.0000086	.....	.....	.6418	.7309	.....	.....	.2025	.1559	.....	.....
000	.0000155	.0000119	.....	.....	.6231	.7112	.....	.....	.2145	.1647	.....	.....
00	.0000233	.0000166	.....	.....	.5510	.6536	.....	.....	.2745	.1950	.....	.....
0	.0000412	.0000360	.....	.....	.3521	.3731	.....	.....	.3824	.3275	.....	.....
1	.000114	.000108	.....	.....	.3155	.3236	.....	.....	.8389	.7950	.....	.....
2	.000177	.000163	.....	.....	.2924	.2895	.....	.....	1.0460	.9630	.....	.....
3	.000268	.000253	.....	.....	.2519	.2597	.....	.....	1.222	1.1510	.....	.....
4	.000514	.000423	.....	.....	.2222	.2326	.....	.....	1.875	1.5410	.....	.....
5	.000760	.000692	.....	.....	.1965	.2044	.....	.....	2.159	1.9930	.....	.....
6	.001175	.001080	.....	.....	.1762	.1842	.....	.....	2.670	2.4580	.....	.....
7	.001760	.001650	.....	.....	.1613	.1653	.....	.....	3.205	3.0500	.....	.....
8	.00290	.00264	.....	.....	.1418	.1490	.....	.....	4.140	3.7680	.....	.....
9	.00413	.00396	.....	.....	.1340	.1357	.....	.....	4.875	4.5260	.....	.....
10	.00662	.00638	.....	.....	.1171	.1198	.....	.....	6.072	5.8120	.....	.....
11	.01065	.01006	.....	.....	1031	.1068	.....	.....	7.830	7.4000	.....	.....
12	.01830	.01585	.....	.....	.0893	.09624	.....	.....	10.450	8.9820	.....	.....
13	.02665	.02425	.....	.....	.0833	.08772	.....	.....	12.000	10.8300	.....	.....
14	.03860	.03585	.....	.....	.0769	.08000	.....	.....	14.070	13.0200	.....	.....
15	.06980	.05572	.....	.....	.0651	.07262	.....	.....	19.680	15.7000	.....	.....
16	.1035	.09250	.....	.....	.0597	.06579	.....	.....	23.330	20.8100	.....	.....
17	.1491	.1320	.....	.....	.0564	.05988	.....	.....	26.220	23.2500	.....	.....
18	.2655	.2055	.....	.....	.0513	.05452	.....	.....	31.710	27.9900	.....	.....
19	.3415	.2665	.....	.....	.0439	.04965	.....	.....	43.200	33.7400	.....	.....
20	.6100	.4799	.7190	.5580	.0389	.04444	.03610	.03814	54.200	42.6000	63.90	58.50
21	.9150	.7110	1.104	1.010	.0353	.04082	.03228	.03440	65.170	50.8000	78.90	72.10
22	1.345	1.000	1.541	1.442	.0322	.03745	.03978	.03114	80.100	59.3100	91.80	85.90
23	2.218	1.600	2.760	2.367	.0291	.03552	.02618	.02814	98.300	70.9000	122.3	105.2
24	3.241	2.339	4.280	3.625	.0271	.03190	.02360	.02555	113.300	81.7800	149.6	126.7
25	4.361	3.415	6.620	5.530	.0263	.02984	.02127	.02328	121.200	95.0100	184.1	153.6
26	6.666	5.003	10.400	8.382	.0249	.02726	.01921	.02136	147.000	109.6000	225.9	182.5
27	11.01	7.250	15.79	12.73	.0208	.02567	.01734	.01938	192.000	126.3000	277.1	221.8
28	17.04	10.50	24.30	19.49	.0184	.02403	.01578	.01772	234.000	144.2000	334.5	266.2
29	23.11	14.26	37.00	28.60	.0177	.02259	.01426	.01624	255.200	163.2000	409.5	315.8
30	34.42	21.21	56.21	43.12	.0168	.02131	.01296	.01497	296.600	183.5000	486.9	373.3
31	49.85	30.10	85.98	63.60	.0156	.02009	.01182	.01381	342.600	206.3000	597.2	436.6
32	70.58	41.00	128.90	91.55	.0146	.01911	.01078	.01279	392.000	228.0000	716.0	509.2
33	102.00	57.90	197.00	127.00	.0137	.01815	.009842	.01188	444.500	253.0000	860.0	545.0
34	147.60	81.30	307.90	201.10	.0128	.01737	.008921	.01106	502.800	276.1000	1046	682.0
35	209.10	100.4	434.80	287.5	.0121	.01666	.008354	.01032	569.100	300.5000	1182	782.0
36	294.00	150.4	506.0	410.0	.0115	.01600	.007686	.009662	632.000	326.0000	1410	890.2
37	445.00	201.0	943.0	533.0	.0109	.01546	.007112	.009074	703.000	348.5000	1640	926.5
38	544.00	268.0	1385.0	823.0	.0105	.01497	.006622	.008561	7[illegible]0.000	371.8000	1910	1137
39	762.00	364.0	2060.0	1145.0	.00993	.01475	.006120	.008163	844.500	394.5000	2225	1251
40	1085.00	488.5	3050.0	1611.0	.00943	.01404	.005630	.007740	935.000	421.0000	2630	1390

For this purpose it is advantageous to arrange the primary and secondary to be separable so that the combination of various primaries with other secondaries may be tested. For example: Assume that a coil having 300 turns in the primary and 2,500 turns in the secondary be considered desirable. Assume the core to be from ½ in. in diameter and provide a winding space of 5 ins., construct five such cores; wind one with two layers of No. 24 wire. This will give approximately 300 turns. Wind one other core with No. 13 wire, obtaining 100 turns and one with No. 19 wire, giving 200 turns; also one with No. 27 wire, obtaining 400 turns and one with No. 32 wire, giving 500 turns. Construct in a similar manner five secondaries, each wound upon a paper tube so that they may be slipped over any one of the primaries. One secondary should be wound of No. 33 wire, giving 2,500 turns in five layers; one with No. 24, giving 1,000 turns; one with No. 28, giving 1,500; one with No. 36, giving 3,000, and one with No. 35, giving 4,000 turns. As each secondary may be tested with

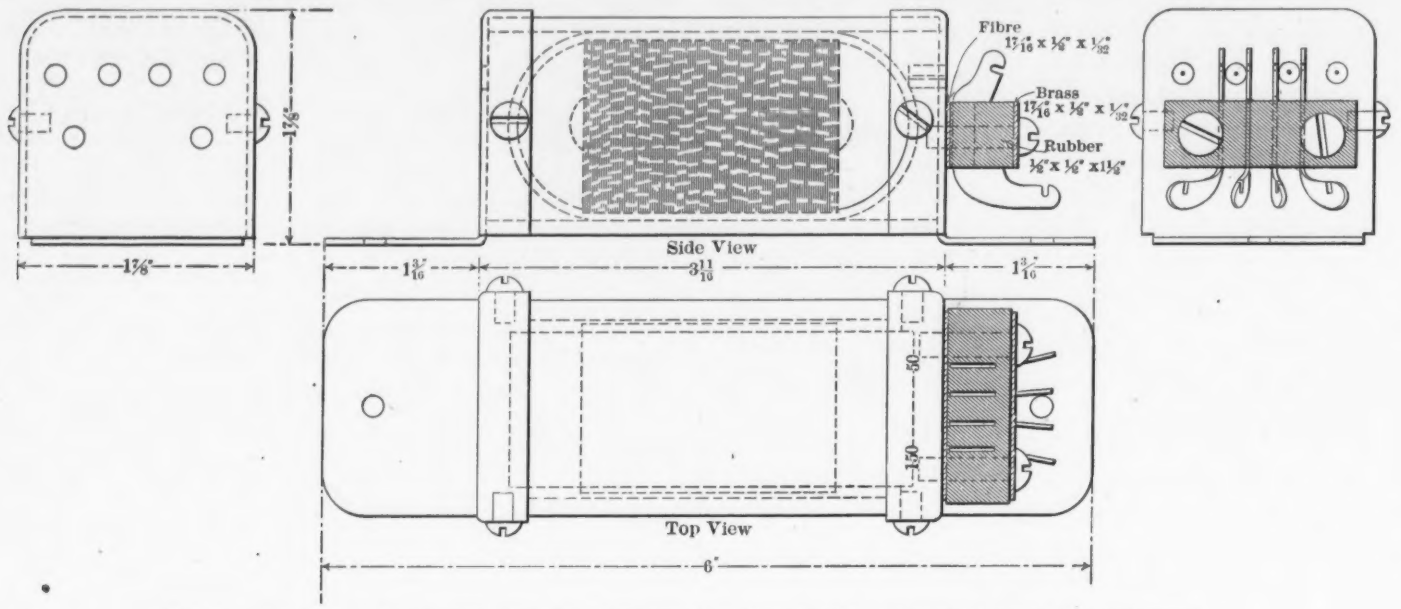


FIG. 11.—IRON-CLAD INDUCTION COIL FOR SWITCHBOARD OPERATOR'S COMMON BATTERY TRANSMITTER.

TABLE VI.—DATA FOR WINDING COILS.

Size of wire: B. & S.	Bare wire.	Diameter in Mils. Over Insulation. Single cotton.	Double cotton.	Single silk.	Double silk.	Turns per Linear Inch. Single cotton.	Double cotton.	Single silk.	Double silk.	Turns per Square Inch. Single cotton.	Double cotton.	Single silk.	Double silk.
0000	460.000	610.000	697.000	.....	.....	1.558	1.368	.....	.....	2.4285	1.8714	.....	.....
000	409.640	590.000	677.000	.....	.....	1.605	1.406	.....	.....	2.5760	1.9768	.....	.....
00	364.800	525.000	622.000	.....	.....	1.815	1.530	.....	.....	3.2942	2.3409	.....	.....
0	324.950	475.000	572.000	.....	.....	2.140	1.980	.....	.....	4.5070	3.9300	.....	.....
1	289.300	299.300	311.300	.....	.....	3.170	3.090	.....	.....	10.0489	9.5481	.....	.....
2	257.630	267.630	277.600	.....	.....	3.540	3.400	.....	.....	12.5400	11.55000	.....	.....
3	229.420	239.420	249.400	.....	.....	3.970	3.850	.....	.....	14.7609	13.8125	.....	.....
4	204.310	214.310	222.300	.....	.....	4.500	4.300	.....	.....	20.2500	18.4900	.....	.....
5	181.940	189.940	196.440	.....	.....	5.090	4.890	.....	.....	25.9081	23.9121	.....	.....
6	162.020	170.020	176.520	.....	.....	5.660	5.430	.....	.....	32.0350	29.4849	.....	.....
7	144.280	152.280	158.780	.....	.....	6.200	6.050	.....	.....	38.4400	36.6025	.....	.....
8	128.490	136.490	142.990	.....	.....	7.050	6.710	.....	.....	49.7025	45.0241	.....	.....
9	114.430	122.430	128.930	.....	.....	7.460	7.370	.....	.....	54.6516	54.3169	.....	.....
10	101.890	108.190	113.590	.....	.....	8.540	8.350	.....	.....	72.9216	69.7225	.....	.....
11	90.742	97.042	102.442	.....	.....	9.700	9.360	.....	.....	94.0900	87.6096	.....	.....
12	80.808	87.108	92.508	.....	.....	11.200	10.390	.....	.....	125.4400	107.9521	.....	.....
13	71.961	78.261	83.661	.....	.....	12.000	11.400	.....	.....	144.0000	129.9600	.....	.....
14	64.084	70.384	75.784	.....	.....	13.000	12.500	.....	.....	169.0000	156.2500	.....	.....
15	57.068	63.368	68.768	.....	.....	15.370	13.770	.....	.....	236.2369	189.6129	.....	.....
16	50.820	57.120	62.520	.....	.....	16.740	15.200	.....	.....	280.2276	251.0400	.....	.....
17	45.257	51.557	56.957	.....	.....	17.740	16.700	.....	.....	314.7076	278.8900	.....	.....
18	40.303	46.603	52.003	.....	.....	19.500	18.340	.....	.....	380.2500	336.3556	.....	.....
19	35.390	41.690	47.090	.....	.....	22.770	20.140	.....	.....	518.4729	405.6196	.....	.....
20	31.961	37.861	42.161	34.261	36.161	25.700	22.500	27.70	26.22	650.4900	506.2500	767.2900	687.4884
21	28.462	34.362	38.662	30.762	32.662	28.300	24.500	30.97	29.07	800.8900	610.2500	959.1400	845.0649
22	25.347	31.247	35.547	27.647	29.547	31.000	26.700	34.39	32.11	961.0000	712.8900	1182.6721	1031.0521
23	22.571	28.471	32.771	24.871	26.771	34.400	28.970	38.19	35.53	1183.3600	839.2609	1468.4761	1262.3809
24	20.100	26.000	30.300	22.401	24.300	36.900	31.350	42.37	39.14	1361.6100	982.8225	1795.2169	1532.9396
25	17.900	23.800	28.100	20.200	22.100	38.000	33.920	47.02	42.94	1454.0000	1150.5664	2210.8804	1843.8436
26	15.940	21.840	26.140	18.240	20.140	42.000	36.290	52.06	46.81	1764.0000	1316.9641	2710.2436	2191.1761
27	14.195	20.095	24.395	16.495	18.395	48.000	38.950	57.67	51.59	2304.0000	1517.0925	3326.8289	2661.5281
28	12.641	18.541	22.841	14.941	16.841	53.000	41.610	63.36	56.43	2809.0000	1731.3920	4014.4896	3184.3449
29	11.257	17.157	21.457	13.557	15.457	56.500	44.270	70.11	61.56	3062.2500	1959.8329	4915.4121	3789.6336
30	10.025	15.925	20.255	12.325	14.225	59.660	46.930	77.14	66.79	3559.3156	2202.4249	5841.4796	4460.9041
31	8.928	14.828	19.128	11.228	13.128	64.125	49.780	84.64	72.39	4112.01562	2478.0484	7163.9296	5240.3121
32	7.950	13.850	18.150	10.250	12.150	68.600	52.340	92.72	78.19	4705.9600	2739.4756	8595.9984	6113.6761
33	7.080	12.980	17.280	9.380	11.280	73.050	55.100	101.65	84.17	5336.3025	3036.0100	10332.7225	7084.5889
34	6.304	12.204	16.504	8.504	10.504	77.900	57.570	112.11	90.44	6068.4100	3314.3049	12568.6521	8179.3936
35	5.614	11.514	15.814	7.914	9.814	82.600	60.040	119.70	96.90	6822.7600	3604.8016	14328.0900	9389.6100
36	5.000	10.900	15.200	7.300	9.200	87.100	62.510	130.15	103.55	7586.4100	3912.5001	16939.0225	10722.6025
37	4.453	10.353	14.653	6.753	8.653	91.870	64.700	140.60	110.20	8440.0969	4186.0900	19768.3600	11144.0400
38	3.965	9.865	14.165	6.265	8.165	95.000	66.800	151.05	116.85	9025.0000	4462.2400	22816.1025	13653.9225
39	3.531	9.431	13.731	5.831	7.731	100.700	68.800	163.40	122.55	10140.4900	4733.4400	26669.5600	15018.5025
40	3.144	9.044	13.344	5.344	7.344	106.000	71.200	177.65	129.20	11236.0000	5059.4400	31578.5225	16692.6400

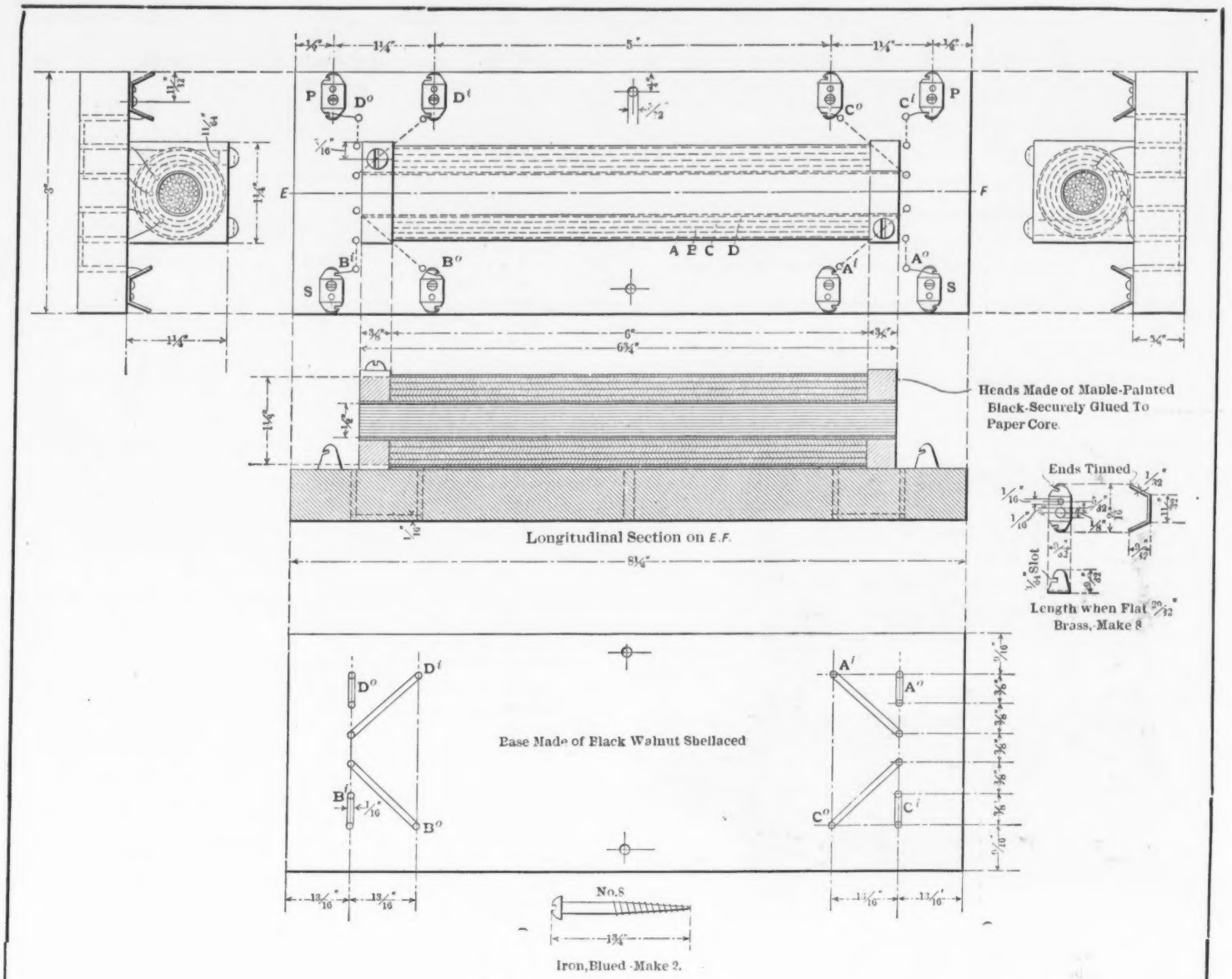


FIG. 12.—DOUBLE-WOUND COIL.

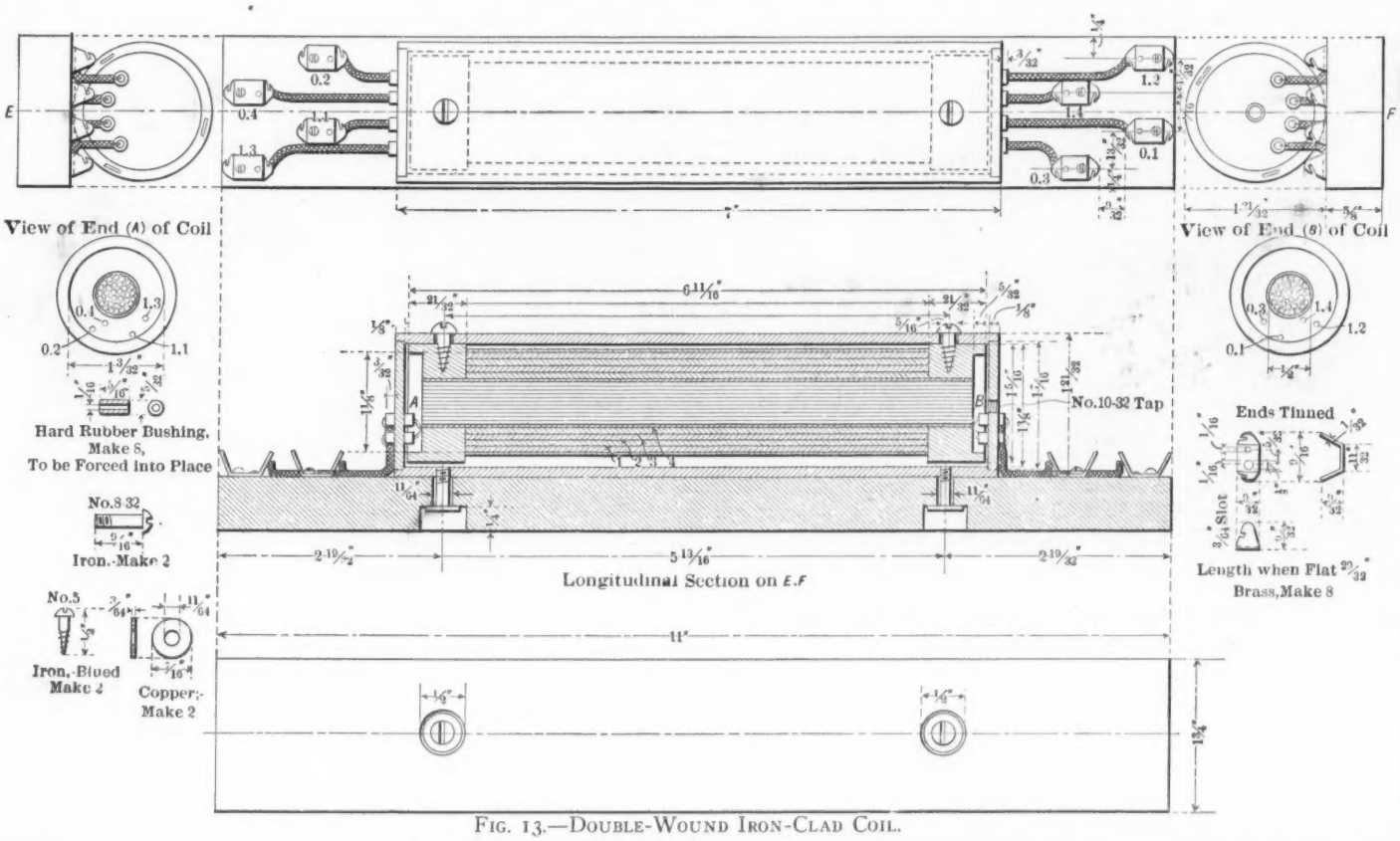


FIG. 13.—DOUBLE-WOUND IRON-CLAD COIL.

any one of the previous primaries, the construction of five coils will give twenty-five combinations. A trial with each of these will show which combination gives, on the whole, the best results under the particular circumstances the coil is to be used, and from a preliminary test of this kind the probable final proportions of the most desirable coil can be readily determined.

SPECIFICATIONS FOR FIG. 10.

Core: Bundle of No. 24 soft iron wire.
Diameter of core, ½ in.
Length of core, 6¾ in.
Winding space, 6 in.
Paper insulation around core 1/32 in. thick.
Winding: Inside winding.
Resistance, .5 ohms.
380 turns No. 18 single covered wire wound from end to end of core in three layers. Cotton covered.
Two layers of common paper insulation around it.
Outside winding:
Resistance, 84 ohms on each side = 168 ohms total.
2500 turns on each side = 5000 turns total.
Wound from end to center and from center to end of core.
Secondary. Two coils separated by hard rubber ring 1/16 in. thick.

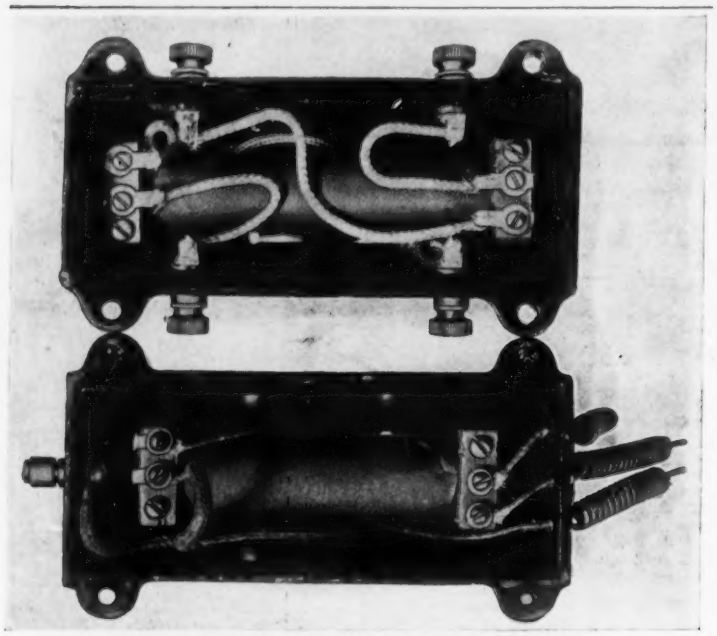


FIG. 14.—INDUCTION COIL IN BASE OF TRANSMITTER.

Terminals: Primaries to operator's telephone.
L. L. to keyboard.
T. T. to telephone.
G. to center of telephone or ground.

SPECIFICATIONS FOR FIG. 11.

Core: 200 soft iron punchings 0.12 in. thick.
Diameter 2¼x½ in.
Winding space, 1 1/16 in.
Heavy parafined paper insulation.
Winding: Inside wiring.
Resistance, 50 ohms each.
2 No. 30 single cotton covered copper wires wound parallel.
Outside winding:
Resistance, 100 ohms.
German silver wire put on and connected in series with one of the 50-ohm coils.
German silver winding wound differentially, insulated by a covering of heavy wrapping paper to prevent contact with the iron casing of the coil.
Terminals: The winding which includes the 50 ohms of copper and the 100 ohms of German silver is the primary and will be stamped 150 ohms at the terminals.
The 50-ohm winding is the secondary and will be stamped 50 ohms at the terminals.

SPECIFICATIONS FOR FIG. 12.

Frame: Two heads, maple painted black ⅜ in. thick 1¼ in. by 1¼ in. Core tube, paper made of a sheet 6¾ in. wide, 9 in. long, .004 in. thick rolled around a mandrel ½ in. diameter and glued.
Tube glued into heads.
Base: Black walnut, varnished, 11 in. long, 1¾ in. wide, ⅝ in. thick.
Core: Best annealed iron wire, varnished, cut 6¾ in. long.
Diameter of wire, .016 in.
Primary: Single white silk covered copper wire.
Diameter, 0.16 in., No. 28 B. & S.; to be wound in two parts, each having 1550 turns.
Resistance, 16 ohms.
Terminals to be reinforced with stranded wire throughout and soldered to clips as in drawings.
Winding to be in two layers.
Secondary: Single white silk-covered copper wire diameter, .013, No. 28 B. & S.; to be wound in two parts, each having 1550 turns.
Resistance, 23 ohms.
Terminals to be reinforced with stranded wire and brought out and soldered to clips as in drawing.
Winding to be in two layers.
Coil to be wrapped with black "seal cloth."

SPECIFICATIONS FOR FIG. 13.

Frame: Two heads to be made of maple, varnished, shaped as at *A A B*, Fig 13.
Heads to be 11/16 in. thick, 1 5/16 in. in diameter.
Core Turn: To be made of a sheet of paper 6⅜ in. wide, 9 in. long, .004 in. thick, rolled on a mandrel ½ in. in diameter and glued.
Tube to be glued into heads.
Base: Black walnut, varnished, 11 in. long, 1¾ in. wide, ⅝ in. thick.
Iron Shield: Annealed wrought iron pipe, 6⅞ in. long, 1¼ in. diameter inside, recessed as shown. Two caps ⅛ in. thick cut to fit pipe.
Heads to be secured by upsetting pipe after coil is in place. All to have two coats of black paint.
Core: Best annealed wrought iron wire, cut 6¼ in. long, varnished.
Diameter of wire, .016 in.
Primary: To be of best white single silk covered copper wire.
Diameter, .0142 m., No. 27 B. & S.; to be wound in two parts, each having 1565 turns and a resistance, 14 ohms. Each part to have two layers.
Secondary: To be of best white single silk covered copper wire.
Diameter, .0142 m., No. 27 B. & S.; to be wound in two parts, each having 1565 turns; resistance to be 21 ohms. Each part to have two layers.
Coil to be wrapped with black "seal cloth."

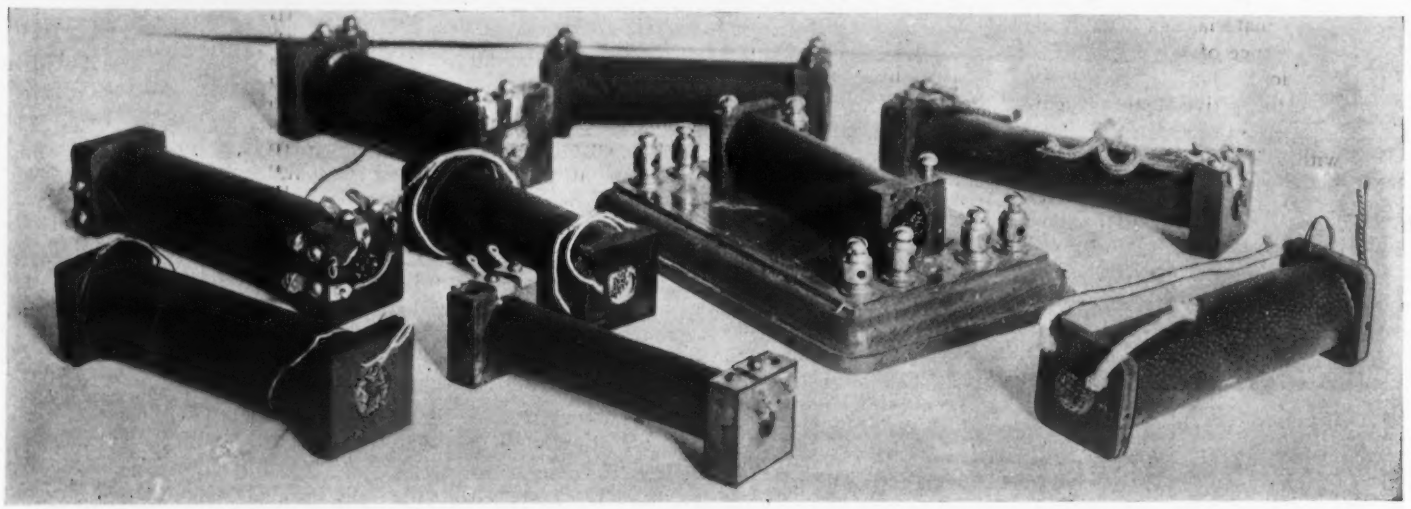


FIG. 15.—A GROUP OF INDUCTION COILS.

Terminals: The terminals shall consist of two (2) strands of wire of the same description as that herein specified for the winding of the coil. That part of the terminal which extends beyond the iron sheath shall be covered with a braided cotton covering. The terminals shall be securely soldered to their respective terminal clips without the use of acid.
Finish: The coil and its accessories shall be assembled and finished in a workmanlike manner.
Test: The fulfillment of the electrical requirements herein called for shall be determined by a comparative test for efficiency against a standard coil.

CURRENT NEWS AND NOTES.

NIGHT ELECTRICAL SCHOOL IN SCHENECTADY.—Several progressive employees of the General Electric Company at Schenectady, N. Y., have initiated a project having for its purpose the founding of a night electrical school.

WASHINGTON UNDERGROUND WIRES.—A bill introduced by Senator Gallinger and reported to the Senate with the recommendation for favorable action by Senator Foraker from the Senate Committee on the District of Columbia, requires all telegraph wires in the District to be put under ground under penalty of a fine of $25 per day.

GAMBLING BY TELEPHONE.—Mayor Harrison has appealed to the Chicago Telephone Company for its co-operation in suppressing pool rooms and "hand books". Warfare on tickers has resulted in substituting telephones and the company finds itself in the peculiar position of a common carrier obliged to accept and maintain the secrecy of all business offered to it in ignorance of its purport, and the operators are forbidden by the rules to listen in to determine whether gambling is being conducted. Listening or "tapping off" the line is in direct violation of the law.

DERI DIRECT-CURRENT ELECTRIC RAILWAY SYSTEM.—A patent granted March 29 to Max Deri, of Vienna, Austria, and assigned to the Stanley Electric Manufacturing Company relates to an direct-current power transmission system stated to be particularly adaptable to traction use. A railway system is divided into such a number of sections that not more than one car shall be on a given section at any time. Each section is fed by an independent generator with two windings in opposition, one being separately excited, and the other in series with the armature. With this arrangement the line voltage varies inversely with the current, and a motor can, therefore, be connected directly with the line from a state of rest or non-excited condition without the intervention of resistance.

STORAGE BATTERY PATENTS.—The only three electrochemical patents granted on March 29 refer to storage battery inventions. Two patents, granted to Mr. C. P. Elieson, of Paris, relate to details of mechanical construction of the grid, and a patent of Mr. A. Meygret, of Paris, refers to a protective envelope for the plates for the purpose of preventing the active material dropping off the plates. This envelope is produced by dipping the plate or grid, after the active material has been applied to it, in a bath consisting of castor oil, essence of turpentine, octonitric cellulose, and ordinary nitrate of cellulose. This method is stated to give an elastic coating which presses the active material against the supporting grid. In order to render it porous, it is afterwards mechanically perforated or provided with a series of fine gashes.

BRITISH STREET RAILWAYS.—The latest Board of Trade returns show that there are 296 tramway undertakings in the United Kingdom, which have cost $200,000,000. These have nearly all been created in the past twenty-five years. Of the total number 142 are owned by municipalities and 154 by private companies. The municipal undertakings, though less in number, have more mileage and cost about $120,000,000; the private, over $80,000,000. The total length of both is over 1,700 miles. Some of the municipal tramways are alleged to make handsome profits, which materially reduce local taxes. During the current year, it is estimated, Nottingham will clear $90,000 from this source, Liverpool $123,000, Leeds $300,000 and Manchester $250,000. In none of these cities do the facilities begin to compare with those afforded in like American cities under private ownership.

ELECTRICAL POLE LINES.—Mr. H. Von Schrenk, chief of the Forest Products Division of the Government Bureau of Forestry in the United States Department of Agriculture, has recently issued a letter and a circular asking for information with regard to poles, pins and cross arms used in the telephone and telegraph industry. He states that the Bureau is to issue a bulletin on the subject of such lumber. A number of questions are asked bearing upon this subject, as to standard specifications, sources of supply, seasoning, average length of life, wire capacity, etc. These questions appear to be somewhat in line with those included in the telegraph and telephone schedules issued by the United States Census Office, with regard to poles, etc., used for those branches of electrical work. The inquiry appears to be based upon the increasing difficulty of obtaining suitable timber for these purposes.

NEW USE FOR THE SEARCHLIGHT.—Prof. C. L. Cory, of the University of California, who is at the head of the electrical engineering department, recently caused a sensation at Berkeley, Cal., by adopting modern military methods to prevent a prohibited college "rush." One of the classes had planned to storm a high hill near the University and paint their class number in white on the hillside where it could be seen for miles around. Prof. Cory had an electric searchlight trained on the hill from the top of the mining building. A force of armed policemen lay in ambush until 1 A.M. when one of them gave the signal, which resulted in the capture of the luckless students, revealed by the powerful rays turned on them as they scaled the heights. About a dozen of the more determined ones were handcuffed until their names and addresses could be ascertained.

A NEW COHERER.—Prof. J. Chunder Bose, the distinguished Hindoo physicist, is represented in the patent budget of March 29 by a patent on a new form of coherer. According to the theory of Prof. Bose, the changes produced on or in the sensitive substances of the coherer are due to molecular distortion, and in order to obtain the best results with the coherer it is necessary that this distortion shall be removed before fresh radiations are received. This is usually done by resort to tapping contrivances, but Prof. Bose offers a method whereby the necessary effect is produced by subjecting the sensitive substances to torsional distortion, imparting to the tube carrying the sensitive substance either a one direction or an oscillatory or vibrational twist. He has, moreover, discovered that certain substances such as galena, tellurium, lead, tin, allotropic silver and a number of others, possess the property of rapid self-recovery from the effects of Hertzian waves. As illustrated, at the end of two pivoted arms are two contact pieces of such material, one being in the form of a plain cylinder, and the other pointed and bearing on the first mentioned. The contacts are normally held together by a spring, the pressure of which can be regulated with great delicacy by means of a micrometer screw. It is stated that this apparatus is self-recovering when the sensitive substance is of the kind enumerated, the distortion produced in the contacts by a wave radiation thereon being automatically removed upon the cessation of the wave.

CONTROLLING INDUCTION MOTORS.—A patent issued several years ago to Analto P. Zani, of Milan, Italy, described an arrangement for starting induction motors, whereby the usual large starting current could be cut down. In this arrangement the rotor had two paths for the induced current, one having a high ohmic resistance and little, if any, self-induction, and the other having an almost negligible resistance, but a comparatively high self-induction. In starting a motor with such an arrangement, a large proportion of the current generated in the rotor will at first flow through the high-resistance path, due to the high frequency of the induced current at low speed. As the speed of the motor rises the frequency of the current decreases, thus correspondingly reducing the reactance in the low-resistance path, until finally when the speed of the motor approaches normal, the impedance of this path becomes so small that nearly all the current generated will flow through it. In a patent issued March 29 it is stated that substantially the same results may be produced with but a single path in the rotor or induced circuit, consisting in effect of the primary of a transformer having a low-resistance path. As illustrated, mounted on the shaft of the rotor are three coils surrounding the same number of cores, the ends of the windings being connected with the ends of the rotor circuit. It has been found that if the members constituting the core magnetic circuit are massive in construction and unlaminated, distinct secondary windings are not required, the magnetic material offering low-resistance inductive paths for eddy currents set up, these eddy currents constituting the secondary current of the transformer. An arrangement is provided whereby when the motor arrives at normal speed the transformer magnetic circuit is opened by means of centrifugal force.

LETTERS TO THE EDITORS.

Steam Turbine Economy.

To the Editors of Electrical World and Engineer:

SIRS:—In your issue of March 5 Mr. Cyrus Robinson, referring to the results of tests of a 1,250-kw steam turbine, published in your issue of February 20, made some criticisms, to which I would ask your kind permission to reply. I quote from Mr. Robinson's letter the following paragraph:

"We have been informed so many times by the manufacturers of turbines of the necessity of high—in fact almost theoretical—vacuum, that it is somewhat of a question if the high economies claimed are not more than offset by the means adopted to obtain them; viz.: the use of large air and circulating pumps, and superheaters, etc."

It is a surprise to me to learn that any manufacturers of turbines have stated that the turbine requires a high vacuum, and I am sure that it would be interesting to your readers to learn from Mr. Robinson what manufacturers of turbines have made such a statement, and where.

It is a fact, as everyone knows who is acquainted with the theory of the steam turbine, that, as the vacuum increases, each successive increment of vacuum is of greater value in the steam turbine than in the reciprocating engine. It follows, therefore, that it is somewhat more to the advantage of the owner of the steam plant to produce a high vacuum for the turbine than for the reciprocating engine, as he gets a greater return for his outlay in the condensing plant. The desirability—not the necessity—of a high vacuum in the steam turbine, as well as in the reciprocating engine, should not be allowed such a prominent place in one's mind as to overshadow the fact that the steam turbine is highly economical with a much lower vacuum than was obtained in the tests above referred to.

In this connection it should be remembered that not only with turbines, but with reciprocating engines, steam users are appreciating more and more every day the desirability of a high vacuum as conducive to station economy. There is to be found in the market to-day condensing apparatus far superior to any which could be obtained a few years ago, and at prices but little higher than those of the less efficient apparatus which was formerly to be had. With such apparatus, at a less operating expense than with poorer apparatus, such vacua as in the tests above cited are easily obtained, either for use with the reciprocating engine or the turbine.

Incidentally I would say that some, if not all, makes of steam turbines are now so constructed that it is absolutely impossible for any air to get into the exhaust steam, except such as may have come with the steam from the boilers, whereas in the reciprocating engine more or less air enters at the low-pressure piston rod and valve stem stuffing boxes; the amount of air so admitted increasing as the packing wears. With the steam turbine, therefore, for a given amount of exhaust steam, a high vacuum is more easily obtained than with the reciprocating engine. This being the case, why should not the steam turbine fairly derive an advantage from the high vacuum which it incidentally assists to create?

Mr. Robinson says that it is unfortunate that I did not give the consumption of the auxiliaries, particularly the air and circulating pumps and superheaters. No observations of these items were made during the tests referred to, principally for the reason that these auxiliaries in our testing plant are not installed as they should be in a power station with due regard to economy, but rather with regard to the necessary flexibility of a plant which is used for testing machines of various capacities temporarily located in various parts of the testing shop. I have quite recently, however, had an opportunity to get indicator cards from the steam cylinder of the same air pump during the test of a turbine which is an exact duplicate of the one previously tested. With the turbine developing 2,120 brake hp, or considerably above rated load, with the barometer at 29.18, and carrying a vacuum of 27.89 in. by mercury column, equivalent to 28.71 in. referred to a 30-in. barometer, the indicated power of the air pump engine was 14.4, or less than seven-tenths of one per cent. of the power developed by the turbine.

A good proportion of this power would be required to maintain only such a vacuum as is found in the older and inferior forms of condensing apparatus. But, for the sake of argument, let us assume that the whole of this power was expended in increasing the vacuum from 27 to 28 in., and let us suppose that the air pump engine consumes as much as 25 pounds of steam per indicated hp-hour. This would call for an expenditure of 260 pounds of steam per hour. Now, referring to the results of turbine tests in your issue of February 20, it will be seen that, when using saturated steam, an increase from 27-in. to 28-in. vacuum decreased the steam consumption of the turbine by 0.68 pound per kw-hour. At the rated load of 1,250 kw, therefore, the steam consumption of the turbine was bettered to the extent of 850 pounds per hour by the increase in vacuum.

We therefore have a balance in favor of the better vacuum equivalent to 850-360-490 pounds of steam per hour, which is a little over 2 per cent. of the total steam consumption of the turbine. Even this 2 per cent. would be worth saving, but as a matter of fact the saving is much greater, because the power required to increase the vacuum can be nowhere near as great as that above assumed. Moreover, in this testing plant the condensing apparatus works under great disadvantage, for the reason that it is connected up to an extensive exhaust pipe system having an abnormal number of turns, offsets, etc., in order to lead to the various testing stands, and the exhaust piping is handicapped by a large number of blank flanges and other temporary joints, thus making it more difficult to maintain a vacuum than in a regular power plant.

As to the power required for working the circulating pump, any data which might be derived from the testing plant would be misleading, as the exigencies incident to a combination of testing and manufacturing operations require a plant quite different from what would be used in a regular power station. In a properly designed power station, moreover, the power required to work the circulating pump of a modern condensing apparatus is extremely small, as the pump requires to do nothing but overcome the friction of the pipes and condenser tubes, etc. With everything properly designed and installed, the entire power required to work not only the air pump, but the circulating pump could be charged to the increase of vacuum from 27 in. to 28 in. and still leave a paying margin of profit, no matter whether the condensing apparatus is used in connection with a steam turbine or with a reciprocating engine.

As to superheat, the gain to be derived from this, in a properly-designed plant, either in a steam turbine or in a reciprocating engine, is too well known to require any defense. In the above referred-to turbine tests, however, the economic results were stated both with and without superheat, and the reader is, therefore, enabled to make the necssary comparisons.

I would quote further from Mr. Robinson's criticism as follows:

"Articles of this kind are apt to be misleading, and as an illustration the operation of a compound reciprocating engine by means of the air pump may be cited, where no steam is actually consumed by the engine itself, the work being done entirely by the 'vacuum,' i. e., atmospheric pressure."

This might be said of any test of any kind of apparatus. In this case, however, as will be seen by referring to the article in your issue of February 20, we took the precaution to have all of the results of the turbine test verified and certified to by a disinterested engineer, whose reputation is above criticism, namely, Mr. Julian Kennedy, the well-known consulting engineer.

PITTSBURG, PA. A. M. MATTICE.

British Technical Education.

To the Editors of Electrical World and Engineer:

SIRS:—I beg you to allow me as an unprejudiced American educated in England, to enter a voice of protest against your editorial on English technical education, in the issue of March 26. I must first point out that your comparison of time spent in the colleges is not quite fair. Nearly all of the men at my college, the Central Technical College, of London, had spent from one to four years at either one of the universities of Oxford or Cambridge or the scientific school of Dulwich College, or at the Finsbury Technical College or some equivalent institution. It will not do to say that the time devoted to technical education in England is short, because the average time spent at the Finsbury College is, say, two years. It is necessary to follow the student to the higher college before one can accurately judge what he is doing. The matriculation examination of the Central covers the subjects treated in the Freshman year of the American college, so that a student practically enters at once into the equivalent of the American sophomore year. That is why

the course at the Central Technical college extends over only three years, instead of four, as in America. An experience of four years in London technical institutions and four years acquaintance with American college graduates, leads me to the conclusion that the American college, in attempting to be very practical, neglects the fundamental knowledge that is so important to the engineer. The English professors, unlike their American brethren, do not attempt to grind out experienced engineers by the wholesale. Care is taken to give the men a good grounding in fundamentals, something that American technical graduates are usually sadly lacking in. I shall never forget my first experience with a Massachusetts Institute of Technology man. He was fresh from college, but seemed to know a great deal about practical details of machine design, wiring, railway work and so forth. We were discussing a recent paper on transformers, published by the Institute, when he asked, "Why does the reading of an ammeter in a transformer circuit include the wattless current? I cannot see how a wattless current can operate an ammeter." Probably he was not a representative M. I. T. man—I hope not—but the mere fact that a man could spend four years at college and get a degree, and then ask such an idiotic question illustrates that the college faculty considers a practical knowledge of transformers more important than a knowledge of the fundamental principles governing these apparatus. I don't think college the correct place to learn engineering practice—that can only be learned by hard work in the shops and drafting room.

Another reason why there are so many students in England who do not take the full three years' course is that men who cannot follow the work are dropped. They are either requested to leave or expelled, for the diplomas and certificates are not awarded to all as they apparently are in many of our American colleges.

Let us not rejoice too noisily over our institutions until we have learned all we can from our friends across the ocean.

New York City. Wm. A. Del Mar.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

Dynamos, Motors and Transformers.

Voltage Variation of a Direct-Current Dynamo and a Direct-Current Voltage Transformer.—Aliamet.—An illustrated description of a direct machine of Lanhoffer. The voltage which can be obtained at the terminals of a direct-current dynamo cannot be varied within wide limits, since an upper limit is set by the saturation of the magnetic circuit while the lower limit is determined by the conditions of good commutation. If the ratio of the highest and lowest voltage under which a dynamo can be operated successfully is called the coefficient of variation of the tension, this coefficient is generally below 1.5. The machine of Lanhoffer enables one to increase it over 5. It consists, as shown in Fig. 1, of two machines with independent stationary field systems while the two armature cores are mounted on the same axle. The armature winding passes over both cores. The excitation of the field $N S$ is kept constant while the exciting current of the field $V V'$ can be varied and reversed. For this reason a rheostat with a reversing switch is provided in the exciting circuit of $V V'$. The field $N S$ may be excited either by a separate source of current or a method of self-excitation may be used; in the latter case the exciting current for $N S$ is furnished from a special winding which is wound only around the core A_1 and not around A_2. If the e.m.f's induced in the common armature circuit by the field $V V'$ are of the same sign as the e.m.f's induced by the field $N S$, the machine $V A_2 V'$ acts as a booster; if the e.m.f's are of the opposite sign, this machine acts as a negative booster. The same arrangement may be used as a direct-current voltage transformer with a ratio of transformation being variable within rather wide limits. In this case, of course, a second commutator must be provided which is supplied from the external circuit at constant voltage. This commutator is connected to the armature winding of core A_1 alone. The transformed current is taken up from the brushes $b\,b'$. The author gives some theoretical notes on the operation of this machine with special reference to armature reaction and to commutation.—*La Revue Elec.*, February 1.

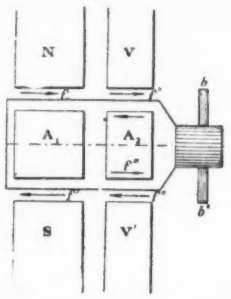


FIG. 1.—VOLTAGE VARIATION.

Speed and Type of Electric Motors.—An account of the discussion which followed the paper of Hobart on the comparative advantages of direct-current motors and induction motors for various speeds. This paper was abstracted in the Digest last week. Thompson said that the contrast between the designs of a number of machines of the same rated output emphasizes several very important features of design. In comparing machines of one kind with those of another, it is useful to go back to first principles and to apply a formula which is applicable to all cases. He has found the following formula very convenient for comparing all kinds of motors and generators, whether direct-current, single-phase or three-phase alternating current. It states that the output of the machine in kilovolt-amperes divided by the speed in revolutions per minute equals the magnetic flux multiplied by a coefficient which varies with the type of machine (being 1 for continuous-current machines and theoretically 1.11 for alternating-current machines), multiplied by the diameter of armature, multiplied by the amperes per inch of armature, multiplied by the number of poles, the whole divided by 1.9×10^{12}. He shows that the eleven machines analyzed by Hobart show some very curious and interesting variations. Drysdale said that Hobart's result concerning cost might well be expressed by saying that the cost is about 25 cents per square centimeter of core area for the large machines discussed by him. Drysdale has found himself that small machines from 2 to 10 hp give a surprisingly uniform value of about 60 cents per square centimeter of core area, and he thinks that this is rather a valuable basis of comparison, since, when taken into consideration with the Steinmetz coefficient, it affords a considerable help in design. Meyer expressed the opinion that all the facts brought forward by Hobart are of a theoretical nature, and discussed several details.—Lond. *Elec.*, March 18.

Operation of Alternators in Parallel.—Bohle.—A continuation of his illustrated paper. He shows that the mass of a fly-wheel should be directly proportional to the coefficient of fluctuation of energy and the work done by the engine, and inversely proportional to the coefficient of speed variation and the square of the speed. Multi-crank engines should be given a smaller coefficient of speed variation than single-cylinder sets. There is absolutely no reason why alternators driven by single-crank prime-movers should not give first-class results when running in parallel. Where trouble occurs it is almost always due to resonance. Trouble occurring with single-crank sets and being due to resonance is made worse by interference of oscillations and can be avoided by decreasing the fly-wheel mass if the coefficient of speed variation is as low as 1/200. The fly-wheel mass will still be large enough to count for any irregular changes. The coefficient of speed regulation should, however, never be larger than 1/100. In multi-crank sets, working under similar conditions, the coefficient of speed variation should not be less than 1/150, so that, whenever there is nearly resonance, the fly-wheel mass should be increased. 1/300 should, however, be the limit in the other direction, otherwise the machines become too expensive.—Lond. *Elec.*, March 18.

REFERENCES.

Compensated Series Motor.—Osnos.—A long theoretical article

in which the author develops the diagrams for the compensated series motor and draws from them some general conclusions. While the voltage at the terminals remains constant, the voltage at the stator increases with increasing speed, but the voltage at the rotor (between the brushes connected in series with the stator) always decreases. The stray fields have an effect equivalent to an increase of the primary stator field and a decrease of the primary rotor field or like an increase of the air-gap which always results in a greater phase difference, other things being equal. Concerning the arrangement of the slots he finds that the best arrangement is the uniformly distributed one with a coil breadth equal to the pole pitch.—*Elek. Zeit.*, March 17.

Single-Phase Commutator Motors.—Sumec.—The first part of a mathematical article in which the author intends to give a simple review of the properties of single-phase commutator motors. His method is to first give for each electric circuit of the system under consideration an equation of the e.m.f's and then to represent all these equations by means of vector diagrams. He intends to combine in this way the accuracy of mathematical methods with the clearness of the graphical methods.—*Zeit. f. Elek.* (Vienna), March 20.

Sparking of Dynamo.—Mailloux.—An article with reference to a former article of Browne, in which troubles were recorded that had been experienced with a dynamo sparking on account of a weakened magnetic field in an electrolytic refinery in which a number of tanks had been disconnected. He discusses briefly the possibility of sparkless commutation with full-load current at low e.m.f's and also discusses the prevention of the reversal of the magnetic field due to the counter e.m.f. of the electrolytic vats under certain conditions of switching.—*Electrochem. Ind.*, April.

Power.

High-Tension, Direct-Current Power Transmission.—A note on experiments made on the St. Maurice-Lausanne transmission line on which the Thury system is used. The earth was first used as a return conductor in the ordinary sense, with the transmission voltage equal to the maximum pressure allowable between line and earth and then as the middle wire in a three-wire system with a voltage between the outers equal to double the voltage between earth and either of the outers. On one day, during damp and partially cloudy weather the transmission line was fed with direct current at 20,000 volts and the total leakage amounted to 0.01299 amp., which corresponds to a loss of 0.0866 watt per insulator. When the earth was substituted for one conductor during the ordinary service of the power transmission the drop of volts at the earth plates at Lausanne was observed to be 25 volts and that at St. Maurice 185 volts, the resistance of the earth being negligible.—Lond. *Elec.*, March 18.

References.

Motor-Driven Roller Tables.—Kingsbury.—A full account of tests of motor-driven roller tables at the Duquesne steel works of the Carnegie Steel Company. The object of the tests was to determine data for use in estimating the sizes of motors required in this class of service. The tests were made during the regular operation of the machinery; additional runs were made without loads on the rollers, for determining the no-load friction. The first test was made with a roller table in a 40-in. mill and the second test with a skew table for a 14-in. mill. The article is fully illustrated by diagrams and the results of the tests are given in tables, but it is impossible to abstract them briefly.—*Iron Age*, March 31.

Electric Cranes.—The first part of a fully illustrated paper read before the Vienna Electrical Society on some recent styles of electric cranes. Among them is one which is designed more with a point of view of preventing accidents during lifting or lowering the load than with an intention to get a high current efficiency. As a special feature of the crane is mentioned the use of series motors and series brake magnets which are believed to be more suitable and safer for heavy crane service, since the series motor develops a higher torque for the same current consumption than the shunt motor, while it has the great advantage of automatic speed regulation; that is light loads are lifted more quickly than heavy loads. The series brake magnet is also considered to be better for the purpose of safety. Various constructions of new cranes are illustrated. The article is to be concluded.—*Zeit. f. Elek.* (Vienna), March 20.

Indicator Diagrams.—Concerning the applicability of electrical methods for taking indicator diagrams. (See the abstract on electrical methods for measuring temperatures, under "Units, Measurements and Instruments.")

Traction.

English Electric Railways.—A long editorial review of this subject. The first electric railway in the United Kingdom between Portrush and the Giant's Causeway was opened in 1883. It was built on the third-rail system, but was altered into an ordinary overhead trolley system in 1899. Another short electric railway on the third-rail system was opened at Brighton in 1883 and this is still running. These lines were both very light railways, practically tramways. Two conduit tramway lines were built, one between Gravesend and Northfleet, the other at Blackpool; "but as in the case of many other engineering developments, England took the initiative and then paused, America worked further at the problem and the fully-developed American systems were then brought over to England." The City & South London Railway Company opened the first "tube" line in 1890; in 1893 the Liverpool overhead railway was opened; in 1898 the Waterloo City "tube," and the Central London Railway in 1900. The first steam railway to be electrified was the Mersey Railway, the second is the Liverpool-Southport section of the Lancashire & Yorkshire Railway and the third will be the Tyneside lines of the North-eastern Railway. While the Mersey Railway is self-contained the Liverpool-Southport line, although three times its length, is but one section of the large network of suburban lines owned by the main railway company serving Liverpool. The success of this section will, therefore, mean the electrical equipment of all the other suburban lines of the Lancashire & Yorkshire Railway, so that standardization of track and working voltage was important. A third-rail system was chosen with the third rail outside the running rails and 3 ft. 11½ in. from the center of the 4-ft. 8½-in. gauge. The line voltage was fixed at 600. In the Lancashire & Yorkshire system a fourth rail is employed in the center of the track, but it is not used as a contact rail, being simply bonded to the running rails to decrease the resistance of the return conductor. Three-phase generation and distribution at high pressure is used, with conversion by transformers and synchronous converters to 600-volt direct current in sub-stations. In choosing between direct control and indirect control by means of electromagnetic or electropneumatic switches for several car trains, the company has decided in favor of the former. A double unit system has been adopted with a motor car at each end of the train and two trailers in the middle. This has necessitated the use of no less than eight cable couplings from one end of the train to the other. Two main cables, from auxiliary cables for the series-parallel control, and two cables for working the reversing switches at the motors. There are thus two controller barrels worked by one handle in the cab of each motor car, each barrel controlling the four motors under one of the motor cars. By this method the "contactors" or the electropneumatic devices of the usual multiple-unit systems are dispensed with. (See also the next abstract.)—Lond. *Elec.*, March 18.

English Electric Railway.—The first part of an illustrated description of the electrical equipment of the Liverpool-Southport section of the Lancashire & Yorkshire Railway. This will be the first section of a main-line railway to be worked electrically in England. The distance between Liverpool and Southport is nearly 18½ miles, while the total length of track equipped is practically equivalent to 47 miles of single track. Under steam conditions there are about 36 trains per day in each direction, which will be increased to 65 under electric operation. The running time for local trains, which is 54 minutes with steam traction, will be reduced to 38. The train mileage will be increased from 1,900 to 3,200 per day. Electrical energy is generated as three-phase alternating currents at 7,500 volts and transmitted to sub-stations with step-down transformers and synchronous converters of 650 volts pressure, the maximum voltage at the trains being 600. In addition to some rotary converters at the main power house, the scheme embraces three sub-stations. The generating plant contains four 1,500-kw units and one 750-kw set besides the converters.—Lond. *Elec.*, March 18.

Mendel Road.—Thomann.—The conclusion of his illustrated article on the Mendel Railroad in Southern Tyrol. One part of it is ordinary adhesion road, while the last part of which has very considerable grades, is cable road, one car going always down while another goes up. The cable is operated by a direct-current motor, which is supplied from the same motor-generator which also feeds the adhesion road. This motor-generator consists of a 100-hp, 3,600-volt, 42-period, three-phase induction motor, running at 610 revolutions, and a 60-kw, 650-volt shunt-wound direct-current generator, which is connected in parallel with a storage battery of 324 cells with

a capacity of 248 amp.-hours. The high-tension, three-phase currents are transmitted from a hydro-electric plant at a distance of 12 km. The motor which operates the cable is a shunt-wound, 600-volt, 90 to 110-hp, direct-current motor, running at 600 revolutions. Should the car which goes down the mountain carry more than the other one which goes up, the cable motor has a braking effect, since it then acts as generator and sends current into the network. The arrangement of the brakes is described in detail, with the results of tests.—*Eletr. Bahnen,* March, No. 5.

REFERENCE.

Single-Phase Traction.—EICHBERG.—A description, fully illustrated by diagrams and illustrations, of the single-phase traction system on the road from Nieder-Schoenweide to Spindlersfeld, where the Winter-Eichberg motor is used, has been repeatedly noticed in ELECTRICAL WORLD AND ENGINEER.—*Zeit. d. Ver. Deutscher Ing.,* February 27.

WIRES, WIRING AND CONDUITS.

Earth Connections.—MOON.—The first part of an article in which the author points out that a damp situation and a porous soil are not the only necessary conditions required for a good earth connection, but that much depends upon the nature of the soil in which the earth plate is sunk. He gives numerical data on the conductivity of various kinds of soil. He gives some notes on the determination of the conductivity of the soil in a given case. After it has been measured, the resistance of an earth connection can be calculated. He gives the formulæ for special cases and shows that the resistance under the most favorable conditions of an earth plate 2½ ft. square would be about ¾ of an ohm for a plate sunk in the sea, 3 ohms for pure clays, 10 to 15 ohms for mixtures of gravels and clays, and as high as 40 ohms for some mixtures of sands and gravels, or of porous rocks. The least resistance of an earth connection which he has yet measured is 7 ohms, and the mean resistance of a large number of measurements was between 15 and 20 ohms. He gives detailed instructions how to sink an earth plate, and shows that even under the most favorable conditions the resistance of an earth connection is inversely proportional to the dimensions of the plate, and that in many cases it would be little decreased by using a larger plate. A number of small plates, sunk some distance apart, is in any case a more efficient earth connection than one large one; and this is the more so, if the conducting layer of soil is shallow.—Lond. *Elec. Rev.,* March 18.

ELECTRO-PHYSICS AND MAGNETISM.

N-Rays.—Some notes on new properties which N-rays have been found to possess. Blondlot has found that besides the kind of N-rays already described, there exists another kind which reduces the luminosity of a feebly luminous surface instead of increasing it. Bagard has succeeded in reproducing the rotation of the plane of polarization in a magnetic field which was first produced by Faraday in the case of ordinary plane polarized light, and is usually known as the Faraday effect. Since ordinary light consists of waves about 100 times as long as those which make up N-rays, and since according to Faraday the rotation increases as the waves become smaller, it was natural to expect the Faraday effect to be very large in the latter. This has been fully verified by Bagard, who obtained rotations in aluminum and in carbon bisulphide, such as can, with ordinary light only to be obtained in quartz. Blondlot has found a probable explanation of the failure of many other physicists to repeat his observations. It lies in the fact that the emission of light is affected by N-rays in the sense of being concentrated upon the normal rather than upon the tangent plane. Thus an observer watching the surface perpendicularly sees it brighten up while if he watches it along the edge it appears to become duller. In the case of N-rays the reverse is the case.—*Comptes Rendus,* February 29; abstracted in Lond. *Elec.,* March 18.

Demonstrating the Absorption of Radium Radiations.—PASCHEN.—An illustrated note showing that the apparatus of Strutt for demonstrating the positive charge of radium enclosed in a glass tube, may be modified so as to demonstrate also the negative charge of the β radiation which penetrates the glass. As shown in Fig. 2, a glass bottle which may be evacuated contains the small glass tube, *b*, which contains a radium-barium preparation and is suspended by means of the quartz rod, *a*. Two quartz tubes, a_1 and a_{11}, hold the hollow lead vessel, *c*, of a thickness of 2 mm., which is completely insulated from *b*. Through *b* passes in spiral form the platinum wire, *f*, which is connected to the electroscope, *d*. The second electroscope, *e*, is fixed to the lead cylinder. As soon as a good vacuum is reached, both electroscopes diverge, *d* with positive electricity, *e* with negative electricity. It is also possible to demonstrate the current which flows from the interior of the glass tube to the lead cylinder, if both are

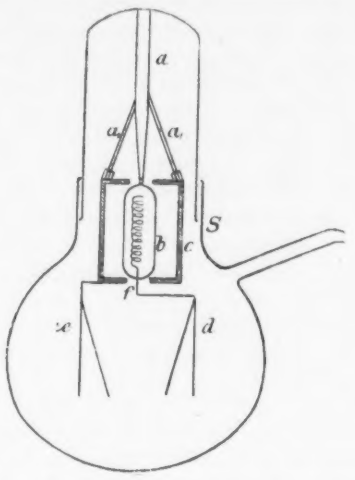


FIG. 2.—ABSORPTION OF RADIUM RADIATIONS.

connected by a wire. This current was first measured by Wien. The divergence of *e* is always smaller than that of *d*, especially on account of imperfect absorption of the β radiation in lead of 2 mm. thickness. Within an hour the electroscopes converge and the charges of their conductors are neutralized, but the neutralization is not complete, both electroscopes showing afterwards a small positive charge.—*Phys. Zeit.,* March 15.

δ-Rays.—A note describing some experiments which Eve has made with Röntgen rays of high penetrating power. Rutherford concludes that Eve's results remove the strongest objection to the view that the δ-rays given out by radioactive bodies are nothing more than an extremely penetrating type of Röntgen rays. It is thus reasonable to expect that these rays are set up as a result of the sudden expulsion of the β particle from the atom of a radioactive body.—From *Nature,* in Lond. *Elec.,* March 18.

REFERENCE.

Electroscope in Vacuum.—PASCHEN.—A note in which he confirms an observation made by Guggenheimer and Korn that two small strips of aluminum, in form of an electroscope, diverge in a vacuum under the influence of light. They believed that the aluminum strips had assumed a positive charge, while the present author thinks that the observation is not an electric phenomenon, but rather due to radiometer action.—*Phys. Zeit.,* March 15.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrolytic Precipitation of Gold.—HAMILTON.—A very full account of the modifications which the Siemens & Halske electrolytic process, as originally worked in South Africa for precipitating gold from cyanide solutions, has undergone in recent years in this country and in Mexico. The main changes are the use of a lead peroxide instead of an iron anode and the fact that the gold is not plated upon the cathode, but is obtained in form of slime, which falls to the bottom. The lead peroxide anodes are practicably indestructible and since there is no compound formed at the anode, like the Prussian blue with iron anodes, they are not covered with canvas. Being indestructible, they do not limit the current density employed. The cathodes are made of tin and are continually kept in the tanks. A good junction between the cathodes and the external conductors is thus rendered possible. The most favorable current density depends upon the amount of gold in solution, the rate of flow of the solution and upon the area of the electrodes. The author gives a full account of measurements which he has made.—*Electrochem. Ind.,* April.

Electroanalysis.—PERKIN AND PREBBLE.—A Faraday Society paper on the electrolytic analysis of gold. They recommend the use of solution of gold salts in ammonium thiocyanate. With a current density of 0.2 amp. per sq. dm. the deposition of 0.05 to 0.08 gram in gold solutions is complete in from 5 to 6 hours. With a current density of 0.4 to 0.5 amp. it is generally possible, even at normal temperatures, to deposit the gold in from 1½ to 2 hours. The appearance of the deposit is generally better when obtained at low current

densities and from solutions containing small quantities of gold. For removing the deposited gold from the platinum cathodes, they recommend a solution containing potassium cyanide, with an oxidizing agent such as hydrogen peroxide, sodium peroxide or an alkali persulphate.—*Electrochem. & Met.*, February.

Corrosion of Aluminum.—MOTT.—An article, illustrated by diagrams, on the corrosion of aluminum and its prevention. A film forms over an aluminum anode in certain solutions, such as sodium acid phosphate, and this film greatly decreases the rate of corrosion of aluminum. The author gives results of experiments upon the special protective action of this film, which is many times thicker and chemically different from the ordinary film that form upon aluminum in air. The author thinks that utensils such as aluminum jars, cups, combs, etc., and all kinds of aluminum handles could be coated with this film to advantage. Another field of importance is the treatment of electric lines of aluminum exposed along the sea coasts to the corrosive action of sodium chloride.—*Electrochem. Ind.*, April.

Nickel Refining.—GUENTHER.—An account of successful laboratory experiments on nickel refining. He recommends the use of a sulphate or chloride solution and a somewhat elevated temperature, and a current density of 250 to 275 amp. per sq. meter. The electrolyte is kept slightly acid; the content of free acid—either sulphuric or hydrochloric acid—should be 0.03 to 0.25 per cent. At the cathode more nickel is deposited than is dissolved from the anode; the balance is to be continuously supplied to the bath in form of a concentrate salt solution.—*Metallurgie*, March 10.

REFERENCE.

Gibbs-Helmholtz Equation.—CARHART.—An article in which the author shows that while the Gibbs-Helmholtz principle has been proven to be correct beyond doubt by experiments with various cells, yet the Daniell cell should not be quoted among them, since there are no absolutely correct data for any specific solutions of this cell available.—*Electrochem. Ind.*, April.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Electric Nomenclature.—HOSPITALIER.—The author proposes for discussion the following suggestions: He wants them to be taken up by the general body of members of the International Electric Congress in St. Louis, but not by the board of official delegates (which he calls the Senate of the Congress). A physical quantity defined as the quotient of two other quantities gets its name from the numerator in combination with the name of the denominator, the latter in adjective form. A physical quantity defined as the product of two other quantities gets its name by combining the two quantities together and joining them by a hyphen; thus, force-length is work. The following adjectives are proposed: linear for length, surfacic or sectional for surface, volumic for volume, massic for mass, temporic or chronic for time, poweric (puissancique) for power, ergic for energy or work. The symbols in the physical formulæ should be printed in italics, or Greek letters, while the abbreviations or units should be printed in Roman characters. The table of symbols and of abbreviations recommended by the Board of Delegates of the International Electric Congress of Chicago in 1893 and printed as a supplement to the *Proceedings* of this Congress, should be revised, completed and adopted as a table of international symbols and abbreviations for the principal physical and electrical quantities and units. For alternating currents he would suggest the following terminology: active current for what we now call the energy component of the current; imaginary current for what we now call the energy component of the current; imaginary current for what we now call the wattless component of the current; and correspondingly, active power and imaginary power.—*L'Industrie Elec.*, March 10.

Electrogoniometer.—CHAUMAT.—A paper read before the International Society of Electricians in Paris on an instrument of Routin for measuring the phase difference between e.m.f. and current in a three-phase system. The method is a zero method, one e.m.f. u_1 in phase with the current being opposed by another u_2, equal to the former and variable with one of the tensions of the three-phase system, E (Fig. 3). The angle e represents the phase difference to be determined. The principle of the method is indicated in Fig. 4. One essential part of the apparatus is a transformer, the primary of which is in series with the phase $A\,O$ of the three-phase system, while the secondary is shunted by a non-inductive resistance; the tension at its terminals is u_1. The second essential part is a device, called decaleur, which is connected on one side to the three phases of the three-phase system, and which produces at the other side the tension u_2, opposed to u_1. Two hot-wire voltmeters, V_1 and V_2,

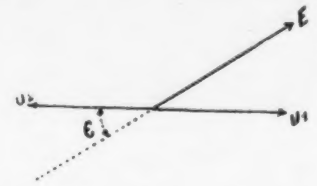


FIG. 3.—MEASURING PHASE DIFFERENCES.

of different sensitiveness, enable one to estimate one-tenth of a volt, which represents an accuracy corresponding to one-third degree for the angle of phase to be measured. The transformer has a primary

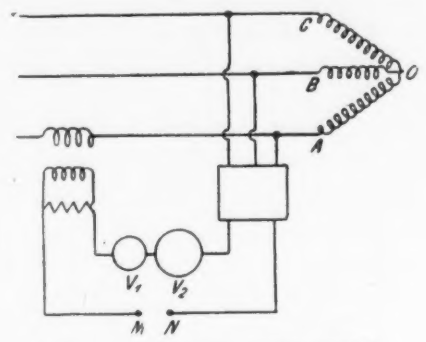


FIG. 4.—DIAGRAM OF CONNECTIONS.

with four coils, each of 25 turns, and permits the use of a current of 25 amp.; the secondary has 1,800 turns. For a phase difference smaller than 1°, the absorbed power is 1.1 watt. The principle of the "décaleur" is shown in Fig. 5, in which $O\,A$, $O\,B$ and $O\,C$ represent by their length and direction the three e.m.f's of the three-phase system. If an insulating rod, $m\,n$ (of a length equal to $O\,A$)

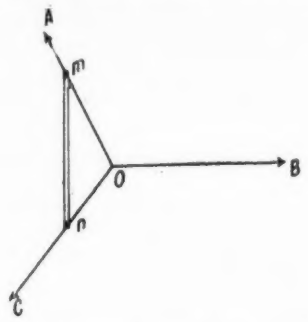


FIG. 5.—DIAGRAM SHOWING PRINCIPLE OF "DÉCALEUR."

is moved with its terminals, m, along $O\,A$ and n along $O\,C$, then the potential difference between m and n is constant, but its phase varies. In this way it is possible to make the phase of u_2 opposite to that of u_1. In practice, this rod, $m\,n$, is moved on a drum with a large number of turns.—*La Revue Elec.*, March 15.

Electrical Methods for Measuring Temperatures.—CALLENDAR.—A note on his concluding lecture on this subject. He demonstrated the applicability of electrical methods for taking indicator diagrams. For this purpose a motor scale had been rigged up in the lecture room and five thermo-couples had been screwed from the outside into the central wall of its small internal combustion engine. Since the thickness of the cylinder casing is about ⅛ of an inch, the temperature indications of the thermo-couples could be taken to represent also the internal temperatures. One couple was placed near the exhaust, another near the inlet and the remaining three were fixed near the top, the middle and the bottom of the stroke, respectively. First he determined the temperatures at these various points. He proved experimentally that the temperature at the exhaust side of the cylinder was considrably higher than at the inlet side, but that, by directing a blast of air from a small fan against the exhaust, this order of things might be reversed and the engine rendered more powerful in consequence. The measurement of the temperatures at the three points of the stroke brought out the fact that these temperatures—contrary to expectation—differed but little, the explanation being that the heat generated in the combustion chamber was

rapidly transported to all points of the stroke by the piston. The indicator diagrams which were taken were perfectly continuous at the very highest speeds (about 2,000 r.p.m.) and with their aid the influence of a retarded or advanced spark and of various compositions of the gaseous mixture could be easily studied.—Lond. *Elec.*, March 18.

New Books.

Die Herstellung von Metallgegenstanden und die Elektrogravure. By Dr. W. Pfanhauser. Halle: Wilhelm Knapp. 146 pages. Price, 7 marks.

This volume is the fifth one of the series of monographs on applied electrochemistry, edited by Victor Engelhardt and published by the well-known electrochemical publishing house of Wilhelm Knapp. Its author, Dr. W. Pfanhauser, is a recognized authority on the subject and the author of several other books on galvanotechnics. In the present volume, after a brief historical introduction, he takes up the discussion of the composition of the copper plating bath, as being the most important representative of the galvanotechnic baths. The results obtained by different investigators are summed up, the influence of concentration currents, etc., is investigated, and the maximum current densities allowable under various conditions are given. Then follows an interesting chapter on the physical properties of the deposited copper, with data of tests for tensile strength, etc. The next chapter deals with the question of the anode copper, and in the following two chapters brief data are given on the bath constants, the deposits and the calculations of the latter, and the arrangement of electroplating establishments. Then follows a compilation of the methods used for the purpose of obtaining even deposits, especially on curved and irregular surfaces, and the methods for removing the deposits from the cathode. In the following chapters are grouped together in the order named, the methods for the manufacture of metallic powders, metallic foils, wires, vessels of various forms, parabolic mirrors and tubes. The next chapter is devoted to electrolytic etching and the last chapter contains a description of Josef Rieder's method of electroengraving. The latter method consists essentially in arranging a steel disc, serving as anode, on top of a block of gypsum, which projects above the surface of the electrolyte. The contact surface of the block is shaped in the form it is proposed to give to the lower surface of the steel disc. The electrolytic vessel is filled with a solution of ammonium chloride, and as the block of gypsum becomes saturated with the latter solution, electrolysis takes place at the contact surface of the block with the iron. As a result, the steel disc is dissolved out corresponding to the shape of the top of the gypsum block on which it rests.

The book is an interesting and valuable contribution to the literature on the subject, the numerous references to journal and patent literature being specially noteworthy. Though the treatment of the various matters dealt with is necessarily brief, the author has succeeded in bringing out clearly the important points, and he has thus been enabled to present a comprehensive review of the state of the art at the present time.

Aufgaben aus der Elektrotechnik nebst deren Lösungen. By Dr. Phil. E. Müllendorff. Berlin W.: Verlag von Georg Siemens. 113 pages, 14 illustrations. Price, 2.50 marks.

This small book of problems for the electrical engineer, with their solution, ostensibly attempts to cover the ground recently traversed by Prof. Atkinson in his "Electrical and Magnetic Calculations." The spirit in which Müllendorff has approached his task is indicated in his preface by the words, "It must be conceded that, for electrical engineers, the vital connections between theory and practice are difficult. The pronounced failure of the modern higher instruction in technical studies is that it leads to no practical applications. Many problems whose solution seems simple when presented in the course of instruction, develop unexpected complications and difficulties when applied in subsequent practice." Such an expression on the part of an author would lead one to surmise that he had not vitally grasped the place and significance of electrical theory, and its real relations and applications in practice; and that a lack of thoroughgoing knowledge of such subjects had led him to place an unwarranted emphasis on certain phases of theory, such as that of the transformer; and that he had perused the older academical methods, rather than the later processes of analysis which are inseparably associated with practice. These assumptions are abundantly borne out by the context. Prof. Atkinson has wisely discriminated in his book between a manual for the solution of problems and a text for the derivation of formulas. Müllendorff has confused the two, and sacrificed the unity of his book. In the selection of matter, Prof. Atkinson has broken away from the old and perhaps classical academical problems, and presented only those cases which have an actual application in engineering practice. In this later work the author seems to have gone over the ground anciently cultivated by Cumming and similar writers.

The opening chapter deals with the problems of the absolute system of units. The second chapter seems wholly out of place in a work of this character. Here the writer attempts a numerical exposition of the theory of potential, a subject which belongs properly to such a work as Webster's, intended for electrical physicists. One meets here the mechanics of the Newtonian potential theorem, whose vital application in practice is remote. In the sixth chapter, given to miscellaneous problems, a brief summary is presented of Kelvin's method in line and station economics, which might profitably have been extended to a more adequate discussion. In the chapter devoted to the technics of alternating currents, the usual academical subjects are attempted and their treatment is purely that of analysis. Here, as in general throughout the book, the differential equation is taken for the departure of the discussion and solution. The matter and method are those of the purely analytical discussion of periodical functions; these, however, are conscientiously worked out, and should prove interesting and suggestive. The concluding chapters deal with vector analysis, methods of least squares, and transcendental functions. Thus the book is a pure mathematical and academical summary of the theory of electrophysics, and its matter and treatment are very distantly related to its title and purport.

While Prof. Atkinson's book is representative of American methods of practical instruction, the book of Müllendorff cannot be accepted for German pedagogy. Though German methods of discussion are in the main more obscure and not so clearly directed as American, yet they are far in advance of those presented in this book. There is a certain humor in mathematics which should save the worker from expending pains to obtain the third decimal place, when the first is doubtful; and this humor should dispel the presumptive gravity of a formidable algebraic array of manipulations with capacity and self-induction of copper conductors in air, when their applications are so generally associated with the obscurities and uncertainties of dielectrics and iron.

Müllendorff's book lacks wholly this sense of humor; it lacks also unity of treatment and the true engineering sense, probably because we have here an academician writing for an electrical engineer. The book may prove useful and interesting as a summary of certain academical methods and processes.

BOOKS RECEIVED.

Controle des Installations Electriques. By A. Monmerque. Paris: Ch. Beranger. 775 pages.

Arithmetic of Electricity. By T. O'Conor Sloane. New York: Norman W. Henley & Co. (16th Edition.) 162 pages, illustrated. Price, $1.00.

Transactions of the American Electrochemical Society. Vol. IV. Philadelphia: American Electrochemical Society. 192 pages. Price, $3.00.

Anwendung und Zukunft der Kondensatoren in der Wechselstromtechnik. By W. Von Bisicz. Berlin: Julius Springer. 88 pages, 26 illustrations.

Die Anwendung der Elektrizitat für Militarische Zwecke. By Dr. Friedrich Wachter. Leipzig: A. Hartleben. 212 pages, 66 illustrations. Price, 4 marks.

Alternating Currents. Their Generation, Distribution and Utilization. By George T. Hanchett, M.E. New York: John Wiley & Sons. 175 pages, illustrated. Price, $1.00.

Electrical Engineering Experiments and Tests on Direct-Current Machinery. By George F. Sever. New York: D. Van Nostrand Company. 64 pages, 22 illustrations. Price, $1.00.

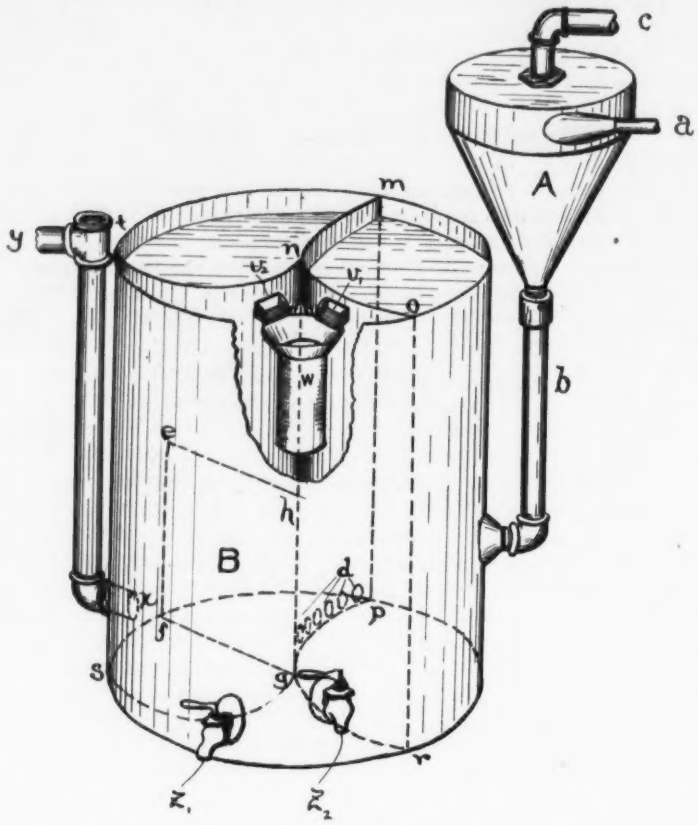
Theoretische Grundlagen der Starkstrom-Technik. By Charles Proteus Steinmetz. Braunschweig: Friedrich Vieweg & Son. 331 pages, illustrated. Price, 9 marks.

Recovery of Cylinder Oil.

BY THOMAS GRISWOLD, JR.

A successful, and so far as the writer knows, an original method for the recovery of cylinder oil is practised at the Midland (Mich.) plant of the Dow Chemical Company. A brief description of the means employed may interest central station men and others engaged in economical power production.

The recovery apparatus which we call a "skimmer" is applied to



OIL SKIMMER.

a vertical cross-compound, direct-connected generating unit of 1,600-kw capacity. The engine cylinders are provided with valves in the heads, and are connected by a large intermediate receiver drum without reheating coils. This receiver is at one side and below the cylinders, so that condensation collects in it and must be removed by a trap. Having noticed that the water discharged by the trap was yellow with oil which rose on standing, we first connected up a series of three oil barrels in cascade, letting the discharge enter the first or highest one tangentially near the bilge. This caused a cyclonic action separating the steam and water, the latter falling to the bottom, the former being led away at the top to an open feed water heater. The water was piped from the bottom of the first barrel to the middle of the third by a pipe. The third barrel had an overflow connected with the bottom. The different parts were so arranged that the second and third barrels were kept nearly full of water. We found that about 95 per cent. of the oil rose to the surface in the second barrel and that there was very little oil left in the discharge which passed the third barrel. This outfit, although successful, was not sightly, nor was it cleanly, but it served to demonstrate that by allowing the water to stand quiet for a few minutes a large percentage of oil could be recovered. After skimming a number of gallons and allowing it to further settle and clarify, we strained it and used it again in the same engine with success.

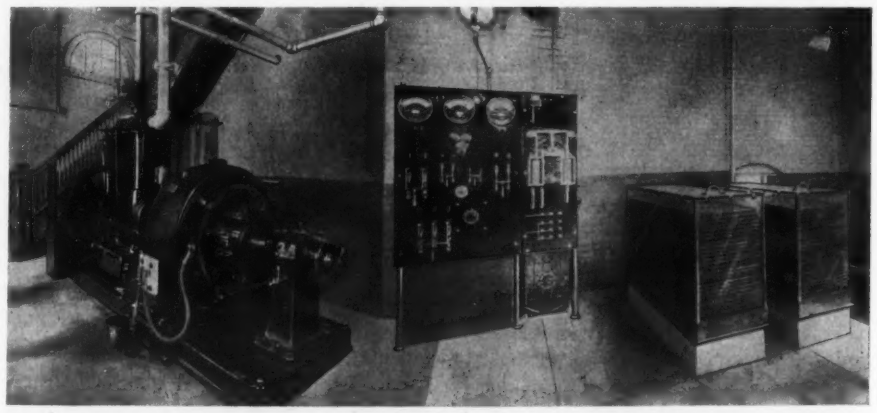
The sketch herewith shows in a diagrammatic way the "skimmer" made to replace the barrels. The device consists of a steam and water separator, *A*, and an oil and water separator, *B*. The trap discharge enters *A* tangentially at *a*, where the water separates by centrifugal force and falls to the bottom, flowing to *B* through the pipe, *b*. The steam is led away to the heater through the pipe, *c*. *B* is divided into three parts by vertical cylindrically-formed partitions. The parts *o, n, m, p, q, r* and *m, n, t, s, g, p* are water compartments connected through the holes at *d*. The latter compartment is also partially divided by a partition, *f, e, h, g*, designed to cut off the water about the discharge, *x*, from disturbing effects due to circulation. The compartment, *o, n, t, s, g, r*, is for the skimmed oil, which, after it has accumulated to a certain extent on the surface of the water in the other two compartments, flows over the weirs at v_1 and v_2 into the screen or strainer, *w*. The height of the overflow, *y*, is regulated to permit the oil to accumulate to a depth of about 8 in. before it rises to the weirs. It is kept fluid by the hot water underneath, and the larger part of the water separates out before it begins to "skim." The oil compartment being bounded on two sides by hot water is also kept warm and the water still further separates there, where it may be drawn off at the faucet, Z_1. The recovered oil is finally drawn at Z_2. The skimmer is also provided with a cover, not shown, and the screen, *w*, is removable for cleaning.

The action of this device is quite automatic and it seems to recover practically all of the high-pressure oil fed to the engine. The recovered oil appears substantially like that originally fed, and so far seems to answer as well on refeeding. The discharge water is still somewhat yellow, and on agitation with a suitable solvent shows oil in small amount. It seems probable that this lost portion may be largely one particular constituent of the oil as originally compounded, and that eventually the repeatedly recovered oil may lose its "quality" and be fit only for low-pressure oil or for other less important purposes of lubrication where the high-pressure grade is not required.

Storage Battery Installation at Binghamton, N. Y.

An interesting storage battery installation illustrating the handiness of the storage battery for isolated plants has just been made in the power house for lighting and heating, which serves the Broome County buildings at Binghamton, N. Y. The plant as first installed was operated with live current and included a 10 x 9 Westinghouse Junior engine, direct-connected to a 37½-kw Westinghouse 110-volt, direct-current generator. As a matter of fact, however, while this plant was entirely satisfactory, it was found cheaper during the hours of limited lighting to burn gas rather than start up the plant. Under these circumstances in order to get the best possible service out of the installation, it was decided to add a storage battery and the contract was awarded to the Smith Storage Battery Company, of Binghamton, N. Y., for one of their novel and ingenious horizontal tray type batteries. The installation as it now stands equipped is shown in the cut herewith.

The addition to the plant consists as shown of 56 elements of the tray type of 280 amp.-hour capacity, together with a battery panel



STORAGE BATTERY INSTALLATION, BINGHAMTON, N. Y.

addition to the original switchboard, this new panel being provided with the necessary switches, voltmeters and ammeters, circuit-breaker and voltage regulator.

The battery is arranged in two piles of 29 trays, each 22 x 48 in., entirely enclosed in glass, something after the manner of a glass showcase, so as to reduce evaporation and exclude dust. The whole presents an extremely neat, simple and workman-like appearance. The result is that no gas is now used in the buildings, and that while the engine during the winter season is only run about five hours a day, there is electric lighting service for 24 hours per

day. It is estimated by the Board of Supervisors, to whom the credit is due for this change, that an investment of $10,000 is saving the county about $2,000 a year. This is but one case out of a great many where the storage battery finds a definite function and plays a very useful part.

Data on the Marconi Wireless Telegraph System.

The annual report of the British Marconi Company gives a variety of interesting data, some of which has been published: The Italian Government has been very active in the extension of wireless telegraphy throughout Italy. A number of stations have been erected during the past year which are available exclusively for the use of ships equipped with the Marconi system through the continuous support and assistance of the government of the King of Italy. The site for a high power station, near Pisa, for communicating with the Argentine Republic, and with the company's high-power stations in the United States and Canada, has been selected by Mr. Marconi, and some of the plant for this station is already on order. Arrangements have also been made for a wireless telegraph service between Italy and Montenegro, in the benefits of which the Marconi Company participates. Negotiations have for some time past been going on between the company and the board of trade for the equipment of lightships with wireless telegraph apparatus, and a contract relating to this service is in preparation.

During the year negotiations with a group of Danish financiers were entered into for the connection of Iceland with Europe by wireless telegraphy, that country being at present isolated from the world so far as telegraphic communication is concerned. The negotiations are at present temporarily suspended, partly owing to the inability to obtain from the English post office the facilities for an inland service which are necessary, and partly to other difficulties.

Fifty-four shore stations are now installed commanding the principal shipping routes, these stations being available exclusively for communication with ships equipped with the Marconi system. Among them are stations worked by the British Admiralty, the Italian Admiralty and Lloyd's. As the stations worked by the governments and Lloyds are increased, an extension of the arrangements for working exclusively with ships equipped with the Marconi system will ensue.

Launch Motors and Controllers.

One of the features of the St. Louis Exposition will be the operation of a number of electric launches upon the waterways somewhat in the same manner as at Chicago and the Buffalo Pan-American. The Hertner Electric Company, of Cleveland, Ohio, has recently

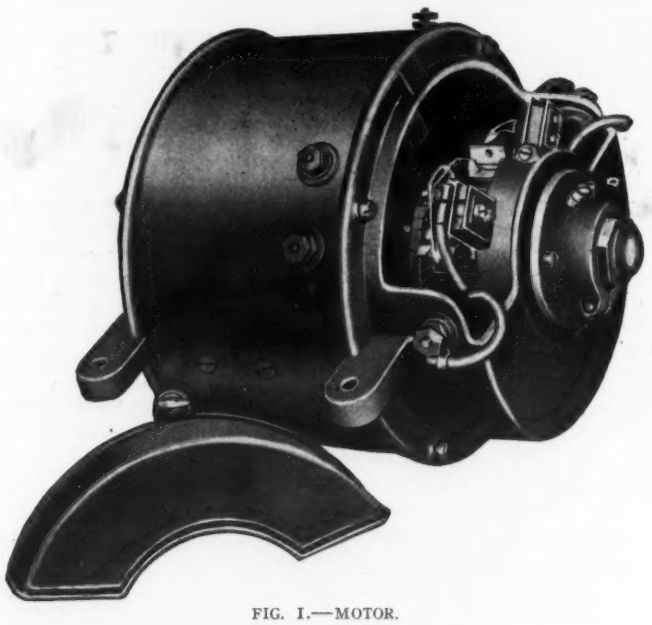


FIG. 1.—MOTOR.

filled an order for 30 special motors and controllers for this purpose, to be used on the launches. The boats in question are under construction by the Truscott Boat Manufacturing Company, of St. Joseph, Mich., and each will seat about 30 persons. Current will be furnished by storage batteries, a 140-amp.-hour, 88-volt Willard battery being furnished for each equipment. As in the case of most of the recent gasoline boats, the motors are of the automobile type and are those built ordinarily by the Hertner Company as their standard 2½-hp for automobile purposes. They are illustrated in Fig. 1 and are multi-polar with forged steel field yoke and laminated poles. Ball bearings are provided so constructed as to take care of end thrust as well as radial pressure. Special heads are used so that the motors are water-tight up to the level of the bearings; the upper half of the front head being left open so as to expose the commutator and brushes, over which a removable cover is provided. The motors are compound wound and designed for high efficiency. The controllers shown in Fig. 2 are arranged for three forward and

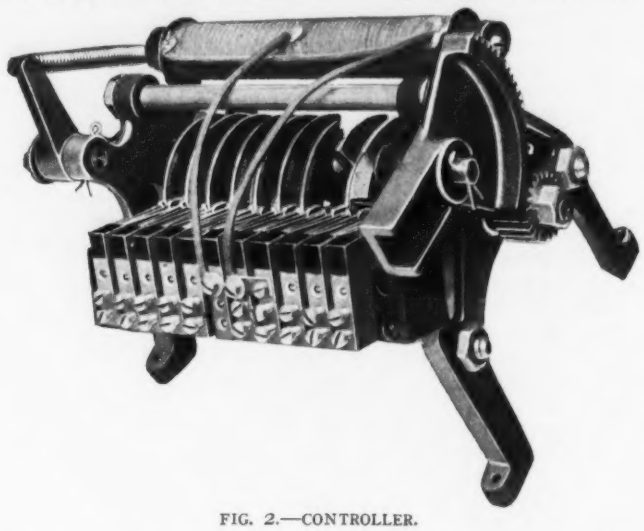


FIG. 2.—CONTROLLER.

two reverse speeds. The first speed forward is on 44 volts with a resistance in series with the armature. The second speed cuts out the resistance. This yields the ordinary rate of running at about 4½ miles per hour when the motor makes 600 r.p.m. For emergencies, the battery is thrown in series, when the motor operates on the full 88 volts and the speed of the boat is hit up to about 6½ miles. The backward speeds are on the 44 and 88 volts, corresponding to the second and third speeds forward. When the controller handle is in the off position the battery is series-connected and can be charged from a regular 110-volt circuit. Exhaustive tests have been made on these equipments, resulting in the St. Louis contract.

Rubber Compound for Electrical Purposes.

A new insulating material has recently been put upon the market by the Electric Rubber Manufacturing Company, which is intended to take the place in some degree of full rubber for the production of battery jars and other purposes. The company named has an adulterant for pure rubber which serves as a substitute for from 25 per cent. and upwards, according to the article required, and which it is said is fully as efficient, although with pure Para rubber costing from $1 to $1.40 a pound, the adulterant can be sold for 12 cents a pounds. With regard to this material, a sample of which made up in a resilient battery jar has been shown us, tests and analyses are submitted by Prof. A. F. Ganz, of the Stevens Institute of Technology, and Mr. W. J. Comly, an electrochemist of New York City. Speaking of the sample submitted to him resembling vulcanized rubber and in the form of a plate measuring 14½ x 11½ x ¼ in., Prof. Ganz states that the insulation resistance determined was greater than 50,000 megohms. Dr. W. E. Geyer, after testing insulated wire with the same compound applied to it and having a thickness of vulcanized insulation of .071 in. on a copper wire of .039 in. diameter, stated that the insulation resistance on one minute electrification at 68° F., after four days immersion in water, was 350 megohms per mile. The capacity per mile was 0.677 microfarad. The resistance to rupture in a length of about 100 ft. tested by means of alternating current was shown by a rupture occurring at 7,000 effective volts. This insulation would appear to have been vulcanized for 40 minutes at 270° F. Other tests are quoted together with the report of Mr. Comly on the resilient battery jars, which stood up under severe tests with sulphuric acid, caustic potash, etc. Some of these jars are reported to have been in use by Altman & Co., in New York City, in their automobile delivery wagons with satisfactory results.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—The stock market was strong in tone but there was slackened activity. The harmonious situation in the settlement of the Northern Securities matter had a good influence, yet it did not attract any great outside public interest. The principal incident of the week was the large purchases of Union Pacific common, supposed to be by Standard Oil financiers, who are interested in the St. Paul road. The Easter holidays created dullness toward the end of the week, and trading became decidedly professional. There was an inclination to accept a cheerful view about iron and steel trade conditions and prospects, and the current belief is that the United States Steel directors will this week declare the regular 1¾ per cent. dividend on Steel preferred, even though the earnings for the March quarter fall to around $10,000,000, as compared with some $25,000,000 for the same three months last year. Steel shares and the second mortgage 5 per cent. bonds of the corporation were decidedly strong. The easy money market was a supporting element in the stock market. The electric and traction securities showed a firmer tone and better prices were secured, all closing with net gains except General Electric, which lost 1⅜ points, closing at 164⅝. Allis-Chalmers preferred was steady at 40, an advance of ½ point. The greatest gain was in American Telephone & Telegraph, which ruled at 124¼ throughout the week, this being also the closing figure and a gain of 4¾ points. Brooklyn Rapid Transit and Metropolitan Street Railway both made a net gain of ⅞ point, the former closing at 44⅛ and the latter at 111⅞. Western Union closed at 88½, thus making a net gain of ¼. Westinghouse Electric closed at 159 ex.-div. The curb market was generally firm, with a reduced volume of business. There was an active demand in Interborough Rapid Transit, which brought about a rise of several points in that stock in the anticipation of the early opening of the subway. This event, however, will not occur, according to a statement from Mr. McDonald, until August, or later, depending largely upon the attitude of the labor organizations during the summer. Below are given the closing quotations of April 5. In Boston stocks were generally quiet on account of the holidays. Massachusetts Electric lost ¼ point. The market was quite devoid of features.

NEW YORK.

	Mar. 29	Apl. 5		Mar. 29	Apl. 5
Allis-Chalmers Co.	7⅛	7⅛	Electric Vehicle	6⅝	7¼
Allis-Chalmers Co. pfd.	40	43	Electric Vehicle pfd.	10	10
American Tel. & Cable	84	85	General Electric	165	163
American Tel. & Tel.	124	126	Hudson River Tel.	..	..
American Dist. Tel	23	23	Metropolitan St. Ry.	111¾	113¼
Brooklyn Rapid Transit	43⅝	44¼	N. Y. & N. J. Tel.	..	..
Commercial Cable	173	170	Marconi Tel.	..	..
Electric Boat	21	20	Western Union Tel.	88⅛	88¼
Electric Boat pfd.	52	50	Westinghouse com.	159	160
Electric Lead Reduction	9¼	9¼	Westinghouse pfd.	175	175

BOSTON.

	Mar. 29	Apl. 5		Mar. 29	Apl. 5
American Tel. & Tel	125¼	126	Western Tel. & Tel. pfd.	75	80
Cumberland Telephone	114	113	Mexican Telephone	1¼	1¼
Edison Elec. Illum.	234	225½	New England Telephone	120¼	120
General Electric	168	163	Mass. Elec. Ry.	18¾	19
Western Tel. & Tel	8¼	8	Mass. Elec. Ry. pfd.	72½	74

PHILADELPHIA.

	Mar. 29	Apl. 5		Mar. 29	Apl. 5
American Railways	43	43	Phila. Traction	95½	95⅝
Elec. Storage Battery	56	56	Phila. Electric	5⅞	5⅞
Elec. Storage Battery pfd.	56	56	Phila. Rapid Trans.	14	13¾
Elec. Co. of America.	8	8			

CHICAGO.

	Mar. 29	Apl. 5		Mar. 29	Apl. 5
Central Union Tel.	..	..	National Carbon pfd.	100	..
Chicago Edison	..	..	Metropolitan Elev. com.	16	..
Chicago City Ry.	165	..	Union Traction	5	..
Chicago Tel. Co.	..	..	Union Traction pfd.	..	..
National Carbon	29	..			

*Asked

FRANCHISE VALUATIONS.—Special franchise valuations in New York City, as computed by the State Tax Commissioners, and on which the corporation franchise tax is levied, increased $16,363,725 over the aggregate for the previous year, the grand totals being respectively $235,157,725 and $251,521,450. In a number of instances the valuations were lower than the previous year, but in the majority of cases, where changes were made the valuations show an increase. The new corporations receiving franchises in 1903 number but 10, and the total valuation of their franchises is but $16,300. This leaves the net increase in 1903 in the old companies $16,347,425. The largest increases is that of the Consolidated Gas Company, of New York, being $3,917,000, and the greatest reduction was in New York Telephone (Manhattan branch), $239,000. The larger of the increases are: New York Edison Company (Bronx), $70,000, and (Manhattan), $1,965,000; New York Mutual Gas Light Company, $251,500; United Electric Light & Power Company, $315,000; Empire Subway, $546,000; New York & New Jersey Telephone Company (Brooklyn), $428,000, and (Queens), $40,000; Brooklyn City & Newtown Railroad, $84,000; Bleecker Street & Fulton Ferry Railroad, $115,000; Christopher & Tenth Street Railroad, $100,000; Metropolitan Street Railway, $67,000; Union Railway (Bronx), $188,000; New York & Queens County Railroad, $70,000; Consolidated Telegraph & Electrical Subway, $733,000; Manhattan Railway, $2,600,000; Edison Electric Illuminating Company, Brooklyn, $1,034,000; New York Telephone Company (Bronx), $43,000; Western Union Telegraph Company, $30,000; Brooklyn City Railroad Company, $260,000. The largest of the decreases are: Brooklyn Union Elevated Railroad, $141,000; Dry Dock, East Broadway & Battery Railroad, $50,000; Forty-second Street, Manhattanville & St. Nicholas Avenue Railroad, $70,000; Long Island Railroad (Brooklyn), $55,000; Brush Electric Illuminating Company, $36,000.

THE MACKAY COMPANIES.—The Mackay Companies have declared a quarterly dividend of 1 per cent. upon the preferred stock, payable April 9 to stock of record March 31. Stockholders of the Commercial Cable Companies were given two shares of Mackay Companies preferred stock and two shares of common for each share of Commercial Cable. The Commercial Company pays 8 per cent. per annum to the Mackay Companies, which distributes it in preferred stock dividends. There were about 900 stockholders of the Commercial Cable Company. A large majority of the stock of the Cable Company has been exchanged for stock of the Mackay Companies. The time for the deposit of this stock with the Old Colony Trust Company, Boston, and Manhattan Trust Company, of New York, has been extended to and including April 18.

CHICAGO CITY RAILWAY CO. shows the following statement for the year 1903, to December 31:

	1903.	1902.	1901.
Gross	$6,435,565	$6,413,181	$5,900,000
Expenses	4,648,341	4,336,504	4,142,841
Net	$1,787,224	$2,076,677	$1,757,159
Depreciation	100,000	180,000	.....
Balance	$1,687,224	$1,896,677	$1,757,159
Dividends, etc.	1,619,991	1,620,000	1,630,000
Surplus	$67,233	$276,677	$127,159

BELL DIRECTORS.—At the annual meeting the following directors of American Telephone & Telegraph Company were re-elected; Charles W. Amory, George F. Baker, Francis Blake, Charles P. Bowditch, George L. Bradley, Alexander Cochrane, T. Jefferson Coolidge, Jr., John D. Waterbury, Moses Williams, W. Murray Crane, Frederick P. Fish, Henry F. Howe, Charles Eustis Hubbard, Charles E. Perkins, Thomas Sanders, Nathaniel Thayer, Theodore M. Vail. Thomas B. Bailey was elected a director to succeed J. Malcolm Forbes.

DIVIDENDS.—The Westinghouse Electric & Manufacturing Company has declared a quarterly dividend of 2½ per cent. on preferred and assenting stock payable April 11. The Electric Storage Battery Company has declared a dividend of 1¼ per cent., payable April 1. The Binghamton (N. Y.) Railway Company has declared a dividend of 2 per cent., payable April 11. The Mackay Companies have declared a quarterly dividend of 1 per cent. on the preferred stock.

SNOQUALMIE FALLS POWER.—It is stated in Seattle (Wash.) dispatches that the Snoqualmie Falls & White River Power Company, with $3,000,000 capital, has acquired the property and business of the Snoqualmie Falls Power Company, the White River Power Company, the Seattle Cataract Company, and the Tacoma Cataract Company.

SALT LAKE CITY, UTAH.—A contract has been entered into between the Salt Lake Railroad Company and the Western Union Telegraph Company, which gives the latter corporation wire privileges and the right to handle all commercial telegrams along the line of the new railroad.

HUDSON RIVER TELEPHONE.—The Hudson River Telephone Company reports a gross for the year ended December 31, 1903, of $883,885, increase $96,555; net, $269,852, increase $33,288; surplus after charges and dividends, $18,572, decrease, $19,464.

ELECTRIC LIGHTING COMPANY EARNINGS.—Messrs. Stone & Webster report the earnings of the following companies for the month of January, 1904:

TERRE HAUTE ELECTRIC CO.

	1904.	1903.	Inc.	Dec.
Jan. gross	$41,188	$33,535	$7,653	....
Net	11,321	7,971	3,350	....
Surplus	1,792	1,428	363	....

TAMPA ELECTRIC CO.

	1904.	1903.	Inc.	Dec.
Jan. gross	$24,987	$22,579	$2,408	....
Net	7,070	9,063	....	$1,993
Surplus	4,942	7,093	....	2,151

EDISON ELECTRIC ILLUMINATING CO. OF BROCKTON.

	1904.	1903.	Inc.	Dec.
Jan. gross	$11,951	$10,447	$1,504	....
Net	5,967	2,414	3,553	....
Surplus	4,898	1,613	3,285	....

LOWELL ELECTRIC LIGHT CORPORATION.

	1904.	1903.	Inc.	Dec.
Jan. gross	$22,217	$21,992	$224	....
Net	9,641	6,813	2,827	....
Surplus	8,036	5,952	2,083	....

SAVANNAH ELECTRIC CO.

	1904.	1903.	Inc.	Dec.
Jan. gross	$39,734	$38,521	$1,212	....
Net	14,787	12,990	1,797	....
Surplus	4,224	3,406	817	....

MINNEAPOLIS GENERAL ELECTRIC CO.

	1904.	1903.	Inc.	Dec.
Jan. gross	$56,084	$51,222	$4,862	....
Net	23,591	22,145	1,446	....
Surplus	13,694	13,347	347	....

SEATTLE ELECTRIC CO.

	1904.	1903.	Inc.	Dec.
Jan. gross	$189,813	$174,065	$15,747	....
Net	51,933	35,562	16,370	....
Surplus	28,745	12,120	16,625	....

Commercial Intelligence.

THE WEEK IN TRADE.—The wet weather is still throttling trade. "Low temperatures, heavy rains, bad roads and floods, the latter in the Ohio and tributary valleys," *Bradstreet's* notes, "have checked spring trade, delayed collections, discouraged Easter demand and closed a three-months' period of rather backward business in the North, East and West." While this report seems rather discouraging on its face there are some redeeming features. Agricultural implement men are doing well and have done what is probably their best season's trade on record. The railroads, too, are better off, and are gradually getting the upper hand in the transportation difficulties. In the South wholesale trade was never better than it is at present, and the feeling in the iron and steel trades is of a much more cheerful character. The agricultural situation is very satisfactory, and large yields are looked for. An enormous cotton acreage will be planted. Dry goods distribution is behind last year at all the leading markets. Textile machinery is not running full and the demand for cotton goods is backward, high prices being a bar to activity. The trade outlook on the Pacific Coast is good, notwithstanding the unfavorable weather conditions there. In the iron situation the outlook is satisfactory. Furnaces are filled up with orders for the second quarter, and prompt deliveries of pig iron and billets are being extensively demanded. There is a good call for finished products, effects of labor troubles being noted in structural material, however. Large tunnel work and pipe contracts are expected to call for an immense quantity of iron. Copper was notably strong. Lake and electrolytic are quoted at 12¾c. to 13c. and casting stock at 12½c. to 12¾c. The business failures for the week ending March 31 numbered 212, according to *Bradstreet's*, against 215 the previous week and 145 the corresponding week last year.

PRODUCTION OF MICA IN 1902.—A report on the production of mica in 1902 by Dr. Joseph A. Holmes, abstracted from the annual volume of Mineral Resources, published by the United States Geological Survey, shows that the total quantity of mica produced in the United States during the year 1902, as reported to the Survey, was as follows: Plate mica, 373,266 pounds, valued at $83,843; scrap mica, 1,028 short tons, valued at $13,081, and mica rough as mined, or unmanufactured, 372 short tons, valued at $21,925; making a total value of $118,849. The increase in the production of plate mica during the last three years is due to the increasing quantity of small-sized mica discs and rectangular sheets that have been cut for electrical purposes. During 1902 there was a large falling off in the production of scrap mica, which in 1902 amounted to 1,150 short tons, valued at $14,606, as against 2,171 short tone, valued at $19,719 in 1901. The tables which show the great increase in the importation of mica during 1902 are significant. This increase, valued at $131,278, is larger than the total value of the product of mica in the United States during 1902. It illustrates the increasing demand for mica in this country. Although mica is widely distributed in the United States, actual mining has been limited, during the last few years, to North Carolina, New Hampshire, South Dakota, New Mexico, Idaho, Virginia and Colorado. Some development work has also been carried on in California, Nevada, Maine, Alabama and Georgia.

NEW YORKERS IN CONTROL OF MONTEREY PLANT.—The firm of J. G. White & Co. and the Wall Street banking house of N. W. Halsey & Co. have acquired control of the Monterey Electric Light & Power Company, which operates an extensive plant at Monterey, Mexico, for lighting and general power purposes. The Monterey Light & Power Company has been incorporated under the laws of the State of New Jersey with a capital of $500,000. P. G. Gossler, formerly general manager of the Montreal Light, Heat & Power Company, and now head of the operating department of J. G. White & Co., has been elected president; Robert Lewis Hoguet, of the law firm of Hornblower, Byrne, Miller & Potter, is vice-president, and Harry R. Tobey, of N. W. Halsey & Co., is secretary and treasurer. The directors are Mr. Gossler, Chester Griswold, treasurer of J. G. White & Co.; Roger H. Williams, of N. W. Halsey & Co., and Morris K. Parker, of the same firm. The plant is to be remodeled and considerably enlarged. About 1,000 kw of additional equipment has been ordered. There will be a 500-kw Curtis turbine. Two 240-kw belt-driven alternators, one 125-kw engine-driven exciter generator and two 7½-kw belted exciter generators, transformers, etc., have also been ordered from the General Electric Company. One hundred and fifty General Electric fan motors will also be shipped. The boilers will be Babcock & Wilcox.

PEARSON SYNDICATE TO SUPPLY POWER TO EL ORO.—The Mexican Light & Power Company, Limited, has determined to transmit power to El Oro—one of the most extensive mining camps in the southern republic. The current will be generated at the Necaxa plant, which is now being hastened to completion. This plant is to have an initial capacity of 45,000 hp, the equipment consisting of Escher-Wyss turbines, Siemens & Halske generators and General Electric transformers. Later on it will be equipped with further machinery, which will bring up the development to no less than 80,000 hp. The use of electricity at El Oro will permit of the working of several low-grade mines now lying dormant owing to the prohibitive cost of steam power. It is estimated that electric current can be furnished at less than half the cost of the existing means of operation. Primarily, it was the intention of the Mexican Light & Power Company, in which F. S. Pearson is one of the leading spirits, to furnish current for use in Mexico City and vicinity. The extension of the transmission lines to El Oro, representing a total of about 175 miles, will make the system one of the largest in the world.

EQUIPMENT FOR A BRICK FACTORY.—The Schwarz System Brick Company, 8-10 Bridge Street, New York, has just installed at Charleston, S. C., the first brick plant in this country to be electrically operated throughout. The initial capacity of the equipment is 75 hp, but it will be considerably added to in the near future. The generator is a 50-kw, 250-volt, 850-r.p.m. machine built by the Northern Electrical Manufacturing Company, of Madison, Wis. It is belted to a 75-hp horizontal engine built by the Houston, Stamwood & Gamble Company, of Covington, Ky. Two Northern motors of 22-hp and 10-hp capacity, 220 volts, are used for operating the elevators, lime crushers, preparing machines and brick press.

CONDUIT FOR CINCINNATI SUBURB.—Mr. G. M. Gest, the expert subway contractor of New York and Cincinnati, Ohio, has just been awarded a contract by the Bell Telephone Company, of Cincinnati, for installation of a large conduit system through Cumminsville, one of the outlying districts of that city. Work is to be started immediately.

NAVAL ELECTRICAL SUPPLIES.—The Bureau of Supplies and Accounts, Navy Department, Washington, will receive bids until April 26 for the following supplies for the Portsmouth, Boston and New York Navy Yards: One 24-in. electrically-driven engine lathe; one electrically-driven deck winch; seven 20-hp electric motors.

SALE OF LIGHTING PLANT.—The Milford Electric Light and Power Transmission Company, of Milford, Ill., has been sold through the agency of J. S. Maurer & Co., to Mr. E. Lindner, of Pecatonica, Ill., for $15,000.

BALL ENGINE CONTRACT.—The Ball Engine Company, Erie, Pa., has been awarded a contract for three 225-hp direct-connected engines for the Seelbach Hotel, of Louisville, Ky.

LARGE EXPORT TRADE.—United States domestic manufactures exported in February, 1904, were greater in value than in any preceding February, and formed also a larger per cent. of the total exports than in any preceding February. For the eight months ending with February the total manufactures also exceeded the total in the corresponding eight months of any earlier year. The fiscal year 1900 was the banner year in exports of manufactures from the United States, but from present indications the fiscal year 1904 will show an even larger total of manufactures exported. The month of February shows a total of thirty-eight million dollars' worth of manufactures exported, against thirty-four million dollars in 1900, while for the eight months ending with February the total is two hundred and eighty-eight millions, against two hundred and sixty-eight millions in the same months ending with February in 1900. These figures, which are presented by the Department of Commerce and Labor through its Bureau of Statistics, indicate pretty clearly that the fiscal year 1904 will show a larger total of manufactures exported than any preceding year. In the eight months for which a record is already made the total exceeds by twenty millions that of the highest record previously attained, that of 1900, while the fact that February, 1904, exceeds by four millions the figures of February, 1900, also indicates that the increase noted in the earlier months of the year is continuing in the latest available months and thus likely to carry the year's total considerably beyond that of 1900. Details as to electrical apparatus are not yet forthcoming, but scientific instruments, including smaller electrical goods show an increase in the eight months from $4,647,940 to $5,935,808.

WAR DEPARTMENT ORDERS 120 BOATS.—The Electric Launch Company of Bayonne, N. J., has just received an order from the United States War Department for 120 boats for the artillery corps' use in planting submarine mines. The boats will be capable of handling 500 mines, and will be used as tenders to the new submarines now building. This is the largest boat order in numbers ever placed by the department, and was obtained by the builders under competitive bidding with all the leading manufacturers of the country. The boats, if placed in line, would equal nearly a half mile in length. Over 30,000 feet of the best boat cedar and 32,000 feet of ship oak will be used in their construction. A ton of copper nails and rivets will be required to fasten the timber together. The boats are now building and will be all completed on June 30, 1904. Charles G. Gates, of New York, has placed an order with the Electric Launch Company for a 23-foot electric yacht tender for use on his yacht "Charmary." The tender will be of the navy type of light weight, with capacity of operating forty sea miles on one charge of the battery. It is the same type that the United States Navy Department has recently purchased, and which are in use on the U. S. S. *Mayflower*, U. S. S. *Florida*, U. S. S. *Dixie* and other warships.

MORE C. & C. MOTORS FOR HAMBURG-AMERICAN DOCKS.—The C. & C. Electric Company, 143 Liberty Street, New York, has secured a further order—the seventh—for 35-hp motors to be installed on the Hamburg-American docks at Hoboken, N. J. The motors will be direct-connected to hoists built by the Consolidated Iron Works, of Hoboken. This installation when completed will be the most extensive electric hoisting plant for dock use in the world. The machinery will handle both cargo, freight and coal. The C. & C. people have taken another order for an 80-hp motor for shipment to the Rogers Locomotive Works, Paterson, N. J. A 40-kw and a smaller generator have been ordered by F. A. Kittredge, contractor of Everett, Mass., for installation in a Massachusetts manufacturing plant.

TO PURCHASE EQUIPMENT FOR MEXICAN MINES.—The Northern Mexico Development Company, which was recently organized under the laws of New Mexico, with a capital of $1,000,000, has acquired the Aventura & Santo Domingo mining properties, located in the Sabinal district on the Sierra Madre line, for the development of which considerable electrical equipment will be utilized. The company proposes to make a specialty of power plants for the operation of mines, etc. Britton Davis, of El Paso, Texas, is president of the concern, C. N. McAdoo, of Greensboro, N. C., vice-president and treasurer, and D. C. Sutton, of the Candelara Mining Company, at San Pedro, State of Chihuahua, Mexico, has been appointed general manager.

TELEPHONE GROWTH AT COLUMBUS, OHIO.—The directors of the Citizens' Telephone Company, which operates in connection with the United States Long-Distance Telephone Company, have decided to contract for the erection of an exchange building which will be 90 by 90 and three or four stories high. They have also decided to contract for an automatic switchboard that will accommodate 10,000 patrons and give the exchange a full capacity of 18,000 instruments. Their present capacity is only 6,000, but they have applications which have been on file for months to the number of 1,600. A director of the company says: "We paid 8 per cent. dividend last year and also built the Farmers' Telephone line, costing $100,000, out of the proceeds."

OFFICE BUILDING AND APARTMENT HOTEL.—Percival R. Moses, electrical engineer, 35 Nassau Street, New York, will act as consulting expert on the installation of electrical equipment for a ten-story office building, which is to be constructed at Binghamton, N. Y., by the Security Mutual Life Insurance Company. The capacity of the equipment has not yet been determined on. Mr. Moses is about to let lighting contracts for three 65-kw generators to be direct-connected to 13-in. x 12-in. high-speed simple automatic engines for the big apartment hotel now being built at Sixty-ninth Street and Broadway, New York, by the Construction Realty Company.

LIGHTING EQUIPMENT FOR SYDNEY.—Some $1,250,000 are to be expended in an extension of the lighting system in Sydney, New South Wales. Six hundred arc lamps will be used for public lighting, of which 340 will be erected at first. Tenders will very shortly be invited locally. The scheme has no reference to the Sydney City & Suburban Electric Traction system, which is being constructed for the most part with American equipment. The tramways are operated by the New South Wales Railways Commissioners, whereas the lighting system will be carried out by the municipal authorities of Sydney.

SHOSHONE FALLS POWER.—Articles of incorporation have been taken out in Idaho to the Shoshone Falls Power & Lighting Company, which will launch a large power enterprise. A power plant is being built on the Snake River from which current will be transmitted to Salt Lake and intermediate cities. Three power plants in all will be erected with a total capacity of 80,000 to 100,000 hp. The capital stock of the company is $2,500,000, with a bond issue of equal amount. All the stock and half the bonds are subscribed. Prominent men of Idaho and Utah are promoting the company.

ANOTHER MEXICAN PROJECT.—A company to be called the Rosa Amarillo Company is now in process of formation for the purpose of acquiring large properties in Mexico. An extensive electric power plant will be built to operate an electric railway, smelters, etc. M. D. Watson, who is primarily interested in the scheme, is now on his way here with a view to closing the financial end of the deal and awarding contracts for equipment. The property is situated at Cantitlan Purificacion, State of Jalisco.

EXTENSIVE MEXICAN ELECTRIC RAILWAY SCHEME.—The construction of an electric railway between Puebla, one of the leading cities in Mexico, and Vera Cruz, the principal seaport city of the southern republic, is mooted. The proposed line will pass the famous Popocatepetl sulphur volcano, which was recently purchased by a New York syndicate. General Muncio P. Martinez, of Puebla, is primarily interested in the railway scheme. The length of the road will be some 130 miles.

WATER POWER FOR LARGE MEXICAN COTTON MILLS.—Mexican advices state that an American syndicate has purchased the immense water fall known as Calda de Tontepec, located in the district of Acaxtian, in the State of Oaxaca. The syndicate proposes to utilize the motive power to be generated by the falls for the purpose of operating a large cotton factory situated in the vicinity, which is at present run by steam power. The price paid for the water rights exceeds $100,000, United States currency.

PENDING SPANISH CONTRACT.—The Westinghouse interests are figuring on a very important contract for the construction and equipment of a large central power station at San Andres de Polomar, Spain, in which it is proposed to utilize industrial gas for the generating of electric current for transmission principally to Barcelona for light and general power purposes. The length of the transmission line will be about 10 miles.

ELECTRIC TRACTION FOR SANTOS, BRAZIL.—Santos, one of the most flourishing seaport towns in Brazil, having a population of about 10,000 people, is to have an up-to-date American equipped electric traction system. James Mitchell, general manager of the Sao Paulo Tramway, Light & Power Company, Limited, is primarily interested in the project.

PENNSYLVANIA'S POWER HOUSE.—Milliken Brothers have been awarded the contract for the construction of the power house for the eastern section of the Pennsylvania, New York & Long Island Railroad. This is part of the Pennsylvania Railroad tunnel system. About 2,500 tons of structural steel will be used in the construction of the power house.

EQUIPMENT FOR JAPANESE ARSENALS.—The Westinghouse interests have recently been allotted several orders for electrical equipment to be installed in Japanese Government arsenals, etc. The orders were secured through the Japanese house of Takata & Co.

WARSAW EXPOSITION POSTPONED.—The electrical exposition which it was proposed to open at Warsaw, Poland, this year has been indefinitely postponed owing to the Russo-Japanese war.

General News.

THE TELEPHONE.

RIVERSIDE, CAL.—The Sunset Telephone Company will spend $15,000 in the extension and improvement of its service.

LOS ANGELES, CAL.—The Home Telephone Company, of Whittier, is installing a switchboard with a capacity of about 800 telephones.

LOS ANGELES, CAL.—The Home Telephone Company, of this city, has just issued an official statement showing that it has now installed and in operation 11,747 telephones, as compared with 8415 when the plant was taken over from the construction company last October. The authorized capital stock of the company is $3,000,000, with an authorized bonded indebtedness of $2,500,000. The company also announces that it has secured, for itself and affiliated companies in Southern California, the exclusive right to the use of the automatic telephone, and has entered into a contract with the Automatic Electric Company to install in the near future a new station on Grand avenue, in the southwestern section of the city, with 4000 automatic telephones. It will be followed immediately by similar sub-stations at East Los Angeles, Boyle Heights, and eventually the entire plant will be operated under the automatic system.

ALTON, ILL.—The Kinloch Telephone Company has installed a complete fire alarm system in the Alton hose houses in connection with its telephone system.

INDIANAPOLIS, IND.—The recent high water greatly damaged telephone property and impaired the service in this city. The water flooded the conduits.

OAKLAND CITY, IND.—The city council has granted the Oakland City Independent Telephone Company a franchise for a period of twenty-five years.

WARRICK, IND.—The Elberfield & Millersburg Telephone Company has been incorporated with a capital stock of $450. The incorporators are Fred Kampe, Henry Kelle and Henry Ahrens.

DALEVILLE, IND.—The Daleville Telephone Company has filed articles of incorporation with the Secretary of State. The capital stock is $10,000. C. H. Forrest, R. C. Stone and F. D. Rushing are the incorporators.

CAMDEN, IND.—The Camden Coöperative Telephone Company has filed articles of incorporation with the Secretary of State. The capital stock is $4000. U. E. Tesh, C. E. Baker, Fred G. Arnick, J. S. Plank and O. W. Wyatt are the incorporators.

SUMMITVILLE, IND.—The Independent Telephone Exchange at this place has been sold to the Madison and Delaware Counties Telephone Company. The purchasing company will at once improve the local plant, install a modern switchboard and extend and connect the lines with its own system.

LEBANON, IND.—The Central Union Telephone Company has taken steps toward the building of a local system in this city as a competitor of the Lebanon Telephone Company, an independent concern.. The Central Union claims to have a franchise granted by the council years ago that permits it to operate a local system.

LOGANSPORT, IND.—The Home Telephone Company in this city now has 1800 telephones in operation, and a hundred or more applications are on file waiting for telephones. The company has numerous connections with smaller systems and exchanges in the towns of the surrounding country. It has decided to purchase another switchboard, and has contracted with Butterfield & Co. to lay a number of additional cables. The company will establish a local exchange in Young America. Applications for local services in Walton and Galveston have also been filed with the home office.

RICHMOND, IND.—Representatives of the Greenville and Eaton, Ohio, and the Richmond Home Telephone Companies held a meeting in this city March 25 for the purpose of perfecting arrangements for long distance service. The object is to get independent service between Dayton and Richmond this spring in order to make the circuit complete between St. Louis and the East in time for the World's Fair business. The distance between Richmond and Dayton is the only link that remains uncompleted to afford long distance service from St. Louis to Pittsburg and New York. It is understood that the United States Telephone Company will put in the Dayton-Richmond line as it operates the line between Dayton and Pittsburg. Connection will be made at Richmond with the new-long distance lines extending West. When these lines are completed the Richmond Home Telephone Company can get long distance service to all points of importance in the country.

WATERLOO, IOWA.—The United States Telephone & Telegraph Company will build an office building here.

WEBSTER CITY, IOWA.—The Martin Telephone Company will lay 10,000 feet of underground cable during the coming summer.

COOPER, MICH.—The Mutual Telephone Company has just been formed here.

JACKSON, MICH.—The Leslie Telephone Exchange with the United States Telephone Company, will build a trunk line to Eaton Rapids.

LAKE CRYSTAL, MINN.—The Blue Earth County Telephone Company has been incorporated with a capital stock of $25,000. The directors are William Crane, David Crane, and others.

MANKATO, MINN.—At the annual meeting of the Mankato Citizens' Telephone Company the following-named officers were elected: Dr. J. H. James, president; H. A. Patterson, vice-president; W. A. Willard, secretary and treasurer. Reports read at the meeting showed that the company is making steady progress and now has 806 telephones in use.

MEMPHIS, MO.—The Scotland County Telephone Company has been incorporated with a capital stock of $10,000. The directors are H. G. Merritt, C. M. Moore and others.

CAPE GIRARDEAU, MO.—The Cape Girardeau Bell Telephone Company, owned by Henry L. Rosier and John Tiapek, of Ste. Genevieve, has bought the Cape Girardeau Telephone Exchange. The new company expects to begin work at once in changing its system from a grounded to metallic circuit and otherwise improve the same.

ST. LOUIS, MO.—The directors of the Kinloch Long-Distance Telephone Company who went to Indianapolis, Ind., and Louisville, Ky., have returned to the city. They made arrangements for the extension of the present long distance service in several directions. At Louisville, representatives from independent companies in a territory extending through Kansas, Kentucky, Michigan, Ohio and Pennsylvania were met. As a result, arrangements were made to connect a large number of smaller lines in various states under a common management. The St. Louis subscribers to the Kinloch long distance telephones will soon be able to reach Cleveland, Columbus, Cincinnati and other Ohio towns. By June the arrangement will extend to Pittsburg, Harrisburg and Baltimore.

VERDIGRE, NEB.—The Verdigre Telephone Company has been incorporated with a capital stock of $10,000.

GUIDE ROCK, NEB.—The Guide Rock Telephone Company has filed articles of incorporation with a capital of $1000.

ABSECON, N. J.—The Keystone Telephone Company of Philadelphia is building a line between Camden and Atlantic City.

BINGHAMTON, N. Y.—The Hawleyton Telephone Company has been incorporated with a capital stock of $500. The directors are G. W. Vossberg, C. S. Gage and others.

WATKINS, N. Y.—The Reading & Rock Stream Telephone Company has been incorporated with a capital stock of $10,000. The directors are H. H. Smith and H. S. Howard.

ALBION, N. Y.—The Hotel Telephone Company of Albion has been incorporated with a capital stock of $50,000. The directors are C. M. Beattie, Garrison Babcock, Rochester, and G. L. Merrill, Albion.

MONTPELIER, OHIO.—The Montpelier Telephone Company has increased its capital stock from $15,000 to $50,000. W. A. London is president.

HARTSGROVE, OHIO.—The Hartsgrove Citizens' Farmers' Association, which was formed late last year, now has 500 subscribers connected up and 35 miles of toll lines. The system is rapidly being extended. Robert Marro is president and E. W. Hunt manager.

ASHLAND, OHIO.—The Central Union Telephone Company will proceed at once with the work of installing an exchange in Ashland. The Central Union Company has been negotiating for the purchase of the Ashland exchange of the Star Telephone Company, an independent company.

GEORGETOWN, OHIO.—The Brown County Telephone Company, capital $20,000, has been incorporated by J. C. Martin, O. E. Bare, W. J. Marshall, H. C. London and G. Bamback. The company will build an exchange at Georgetown with lines through Adams, Highland and Brown counties.

GREENSBURG, PA.—The Borough Council has granted a franchise to the Johnstown and Pittsburg Long Distance Telephone Company.

PHILADELPHIA, PA.—According to dispatches from Philadelphia the Keystone Telephone Company since the first of the year has installed new telephones to the number of 1200. The statement is made by an official that the net earnings for the first quarter of the present year will surpass largely those of the corresponding period last year, when the profits were $41,000.

HILLSBORO, TEXAS.—The city council has voted to grant a franchise to the Independent Telephone Company.

CUSHING, TEXAS.—Dr. Crawford, of Alto, who has established a telephone exchange here, will make improvements.

DALLAS, TEXAS.—The application of Messrs. Waterbury and Whitney, of Houston, Texas, for a franchise for an independent telephone sysytem for the city of Dallas has been referred to a committee of the city council. There is considerable opposition to the franchise being granted.

BROADFORD, VA.—The Broadford Telephone Company has been incorporated with a captial stock of $5000. L. H. DeForest is president.

PRAIRIE DE CHIEN, WIS.—The Union Telephone Exchange of this city has been sold to J. W. Calloway.

CUMBERLAND, WIS.—The Dunn County Telephone Company will build lines through Dunn and Barron counties. Exchanges are to be put in at Barron, Ridgeland, Cameron, Dallas, Chetek and Rice Lake.

MERIDA, MEX.—Extensive improvements are to be made to the local telephone system here which was recently badly damaged by fire.

SIERRA DE ALMOLYA, MEX.—E. V. Combe is building a telephone line from this place to Vaca station, situated on the Mexican Central Railroad.

ST. JOHN, N. B.—Application is being made by a company seeking the right to conduct a general telephone business in the counties of St. John and Charlotte, N. B. The title of the new company is The Citizens' Telephone Company, and it will be connected with the present Forest Telephone Company at Calais, Me., with a main central office at Calais for both the New Brunswick counties.

OTTAWA, ONT.—The North American Telegraph Company is applying to the parliament of Canada for an amendment to the charter of the company to enable it to increase its capital from $1,000,000 to $10,000,000, and to extend its line to Manitoba and the Northwest and to change its head office from Kingston, Ont., to Winnipeg, Man.

TORONTO, ONT.—The Bell Telephone Company of Canada has offered the Board of Control of the city of Toronto to pay the city $20,000 per year for an exclusive franchise of five years, the price of telephones to remain at $50 and $30 as at present. The Stark Telephone Company offered to furnish telephones at $6 per year, with a charge of one cent per call up to $15. The Canadian Telephone & Telegraph Company offered to furnish telephones at $36 and $24. The Board has taken time to consider these bids.

ELECTRIC LIGHT AND POWER.

SAN FRANCISCO, CAL.—The California Gas & Electric Corporation made its first annual payment, under its sinking fund provisions, to the Mercantile Trust Company on March 15. The money is to be invested in the underlying securities and the bonds of the corporation.

SAN FRANCISCO, CAL.—The Reno Power, Light and Water Company has been incorporated with a capital stock of $1,000,000 by P. L. Flannigan and W. H. Patterson, both of Reno, Nev.; Charles L. Gibb, of Berkeley, and Joseph A. Fontaine and Frank P. Deering, of San Francisco.

LOS ANGELES, CAL.—The Tracy Engineering Company, of San Francisco, wants to install a 500-hp plant for the city of Riverside and sell it to the city at the end of ten years, the city to buy the power in the meantime at the rate of $5.99 per horse power per month and pay for a minimum load of 300-hp.

LOS ANGELES, CAL.—The Alamo Electric Power and Milling Company proposes to install a 500-hp plant at Ensenada, Lower California, to serve the principal mines of the famous Alamo mining district, at an expense for power and milling machinery of not less than $150,000. The company's headquarters are in Los Angeles. W. E. Hampton, an electrical construction engineer of San Francisco, is drafting the plans for the power plant.

SAN FRANCISCO, CAL.—The San Francisco Gas & Electric Co. has, in a general way, planned to make a considerable increase in its electric generating equipment. It is considering the advisability of adding 10,000-kw in generating capacity at the independent plant known as Station "A." This would permit of shutting down the steam plants at the other two power stations. Contracts have been placed with the Westinghouse Electric & Manufacturing Co. for 1300 series alternating arc lamps with the necessary 200-light regulators for the same. The new lamps will enable the company to do away with the direct current series arcs in street lighting as it has already done in commercial lighting.

WASHINGTON, D. C.—The Atlas Light & Power Company has been incorporated here by A. C. Smith, S. J. Lamson, E. W. Scribner, E. L. Bradford, P. H. Burch, R. Wermelle and R. K. Van Mater.

WASHINGTON, D. C.—Bids will be received April 12 at the Bureau Supplies and Accounts, Navy Department, Washington, for furnishing at the navy yards, Norfolk, Va., and Pensacola, Fla., a quantity of arc lamps, electrical supplies, conduit and fittings, etc. H. T. B. Harris, Paymaster-General, U. S. Navy.

TERRE HAUTE, IND.—The Terre Haute Electric Company will build a new power house in this city. Contracts for the building have not yet been let.

CICERO, IND.—The town council has granted a 25-years' franchise to John Plain for an electric lighting plant. Mr. Plain announces that he will at once erect a new electric lighting system here.

MENTONE, IND.—The Mentone Electric Light and Power Company's plant has been sold through the J. S. Maurer & Company agency, of 804 Monadnock Block, Chicago, to J. H. O'Rourke, of Algonac, Mich.

ANNAPOLIS, MD.—A bill was offered in the House by Mr. Lipman to provide for municipal ownership of electric lighting plants in Baltimore City. A motion to lay the order on the table was carried.

MERRIMAC, MASS.—Jas. Dickens, of Newburyport, is preparing plans for the electric light plant for Merrimac.

ST. LOUIS, MO.—The Ada Electric Light and Power Company has been incorporated with a capital stock of $40,000, full paid. The incorporators are Charles I. Patterson, Allen B. Patterson and William F. Klanke.

VERSAILLES, MO.—W. K. Palmer, Kansas City, Mo., is engineer for the municipal lighting plant for Versailles. Plans and specifications are ready. Bids will be required on boilers, engines, generators, switchboard, poles, etc., together with the building.

ST. LOUIS, MO.—The city of St. Louis, through the Harbor and Wharf Commissioner, March 23, formally ratified its previous verbal acquiescence in the contention of the Laclede Power Company, that the latter had riparian rights in front of its station at the corner of Lewis and O'Fallon streets. This gives the company the right to take water from the river which it will use for condensing purposes in the operation of its engines, and ends the controversy which has been going on for two years and which came acute when it was discovered last winter that the power company was building an intake beneath the wharf opposite its works.

ST. LOUIS, MO.—A plan to brilliantly illuminate the new city hall is being worked out by Thomas B. Carter, supervisor of city lighting. The Twelfth street entrance is to be lighted from fourteen posts of artistic design. Six of these will support clusters of 25 incandescent lights. Four smaller posts, with 12 lamps each, will light the circular driveway, and four of the same size will illuminate the portico. Arc lights on specially designed brackets will be placed at the Clark avenue and Market street entrances. The rotunda, now being completed, will be lighted by 2000 incandescent lamps. Of these 250 will form a chandelier below the skylight, and the others will be fixed to the pillars surrounding the rotunda. The fixtures for these are being designed by the architects. Many other lights will be placed in the halls. The total number will be about 5000.

HELENA, MONT.—The Ox Bow, in the Missouri River, near Helena, is to be a thing of the past according to the plans of the Ox Bow Power Company, recently organized. The Ox Bow is a loop in the river about 12 miles around but at one point only a quarter of a mile separates the two turns of the river. There is here a difference in level of about 20 feet, and it is proposed to construct a dam, make a canal, and establishing a power plant at some convenient point. It is estimated that the expense of putting in such a plant will be about $750,000. Before work can be commenced, a congressional enactment, permitting the damming of the river, will be necessary.

WATKINS, N. Y.—The citizens have voted to issue $20,000 bonds to construct an electric light plant, to be operated in connection with the water works.

CANTON, N. Y.—The Canton Electric Light & Power Company has petitioned for a 20-year franchise for lighting the village. It is proposed to install new machinery.

BURGAW, N. C.—John W. Reilly, of Wilmington, is interested in the construction of electric light plants at Burgaw and Clinton.

WAYNESVILLE, N. C.—B. J. Sloan has contracted to furnish this city with power for lighting for 10 years, the power to be generated at the falls of Pigeon River, by the construction of a dam. The capacity of the plant will be 1500-hp.

HAMILTON, OHIO.—The city will issue $5000 bonds for improving the lighting system.

PHILO, OHIO.—C. U. Shryock, of Zanesville, has secured a franchise from this village for the construction of water works and an electric light plant. The villages of Duncan's Falls and Taylorville will also be supplied.

BELLEVUE, OHIO.—The franchise of the Bellevue Light and Power Company expires May, 1905. The council is considering a proposition to erect a municipal lighting plant. A committee has been appointed to investigate the cost of such a plant.

OKLAHOMA CITY, OKLA. TER.—F. C. French, of Oklahoma, has made application for an electric light franchise.

OREGON CITY, ORE.—Supplementary articles of incorporation have been filed by the Oregon Water Power & Railway Company, changing its name from Oregon General Electric Company, under which it was originally formed. Fred. S. Morris, J. Frank Watson, A. B. Croasman, W. H. Hurlburt and William T. Muir are the incorporators.

TERREHILL, PA.—Michael N. Nolt, New Holland, Pa., writes that he proposes constructing an electric light plant on Conestoga River, at a cost of $6000.

CHARLESTON, S. C.—By a new contract with the Consolidated Company, of Charleston, this city will save over $5700 on lights. Arc lights are reduced from $97.50 to $80 per year, to be followed the next year by a reduction to $75.

DAYTON, TENN.—Edgar Stone, of the Dayton Light and Power Company, writes that it is proposed to construct an electric light plant, at a cost of $8000.

KNOXVILLE, TENN.—The city council of Knoxville has named a committee on municipal ownership of the electric light plant. Mayor Gass is reported as being in favor of the new plan.

RUSK, TEXAS.—W. W. Welsh is interested in the construction of an electric plant.

UVALDE, TEXAS.—Colonel Ike Pryor and son, Dave, contemplate installing an electric light and power plant at Uvalde. They are also arranging to establish a large irrigation plant near here.

PRAIRIE VIEW, TEXAS.—An electric light and power plant is to be installed at the State Prairie View normal school, situated here. Prof. Brown, of College Station, Texas, can give information.

RICHFIELD, UTAH.—The Clark Power Company is considering the construction of a power plant near here to supply power for all towns of the county. The plan also includes the construction of electric railways.

WEST SEATTLE, WASH.—The Council has passed an ordinance requiring that all electric light and power wires be placed in underground conduits.

FOND DU LAC, WIS.—The bid of the Citizens' Light, Heat and Power Company, of Milwaukee, for the franchise, under which a new electric lighting and power plant is to be established in this city, was accepted by the Common Council.

SUNDANCE, WYO.—It is reported that the Economic Power Company, organized by Henry K. Mayham, of Denver, Colo., will build a $900,000 power plant west of this place, to supply power and electric light to many towns and mines in the Black Hills.

KINGSTON, ONT.—It was voted to purchase the plant of the Light, Heat and Power Company.

OTTAWA, ONT.—The rights of Mr. E. S. Jenison, of Chicago, to the water power of the Kekabeka Falls and Ecarte Rapids, Ont., have been fully restored by the private bills committee of the Ontario Legislature.

BRANTFORD, ONT.—A peculiar accident happened recently to the electric plant of this city. It appears that muskrats burrowed through the embankment skirting Lake Mohawk, whence the electric plant obtains its power, causing the earth to cave in and effecting a large breach and put the plant out of business. An auxiliary plant was set up, but local factories, run by electricity, were forced to close pending repairs to the embankment. The pranks of the muskrats cost the electric company upwards of $5000.

OTTAWA, ONT.—The Dominion government has determined not only to light the Welland Canal by electricity, but by the same power to operate the gates, valves, bridges and sluiceways of the canal. The electric energy will be furnished by the Cataract Power Company, of Hamilton, Ont. The whole stretch of the canal will be lighted instead of merely the locks as at present. Some 550 arc lights will be distributed between Port Dalhousie and Port Colborne, a distance of 27 miles. At each of the 25 locks there will be six arc lights, while along the banks of the canal there will be one light in every 400 feet. In addition there will be a special equipment of arc lights for the piers at the head and foot of the canal.

MONTREAL, QUE.—The Shawinigan Water and Power Company, of Shawinigan Falls, Que., has just completed arrangements for the erection of another transmission line, from the Falls into Montreal, with a capacity of 10,000 additional horsepower. This entire additional power will be taken by the Montreal Light, Heat and Power Company. In order to meet the increasing demands for power, the Shawinigan company is just completing at its works the installation of a third unit consisting of a water wheel with a capacity of 6000 hp and a generator of 3750 kw capacity, thus giving the company an increased output of 5000 hp. A similar additional unit will be installed this summer.

THE ELECTRIC RAILWAY.

BIRMINGHAM, ALA.—The Bessemer, Brookwood & Blocton Railway & Light Company has been granted a franchise by the city of Birmingham to build an electric railway.

CAMDEN, ARK.—The Interurban Transit Company has been incorporated by H. C. Homeyer, C. P. Brice, C. C. Gunnels and J. G. McDonald. The company proposes to carry passengers and freight and to sell electric power. Capital, $350,000.

WASHINGTON, D. C.—The Old Dominion and Great Falls Railway Company has bought a $23,000 site in Washington for its power plant.

WILMINGTON, DEL.—Rights of way are being secured for the extension of the Middletown & Odessa Electric Railway from Middletown to Clayton and Smyrna.

ATLANTA, GA.—It is stated that the recently incorporated Georgia Traction Company has been successfully financed and that it will be built between Athens and Carnesville, Ga. Mr. Van Wey, of Toledo, Ohio, is president of the company.

FREEPORT, ILL.—Right of way is being secured for the proposed electric railway from Freeport to Polo and Dixon, and application has been made for a franchise in Polo. O. T. Smith is president of the company.

EAST ST. LOUIS, ILL.—Articles of incorporation have been filed by the St. Louis, Vandalia & Eastern Electric Railway, with a capital stock of $50,000. The incorporators are: William M. Folger, Charles G. Sonnerman, George D. Steinhauer, H. C. Doyle, T. N. Lakin, of Vandalia.

CHICAGO, ILL.—The Chicago City Railway Company, Chicago, contemplates the erection of a great central electric power plant at West Thirty-eighth and Halsted streets, to cost $4,000,000, the purpose being to operate all the trolley lines from the one central power plant.

TAYLORVILLE, ILL.—The stockholders of the American Central Traction Company have perfected their organization by electing the following officers: J. N. C. Shumway, president; Ernest Hoover, vice-president; Warren Powell, second vice-president; David M. Sharp, secretary and manager; E. W. Height, treasurer. The company has been incorporated at $250,000, and will begin the construction of interurban lines from here to Assumption, Mount Auburn, Springfield and East St. Louis.

CRAWFORDSVILLE, IND.—It is announced that the Consolidated Traction Company will soon receive bids for the construction of a large power house in this city. Edward Hawkins is president of the company.

WATERLOO, IOWA.—The Rapid Transit Company proposes to extend its line to Ossian.

MARSHALLTOWN, IOWA.—Petitions are being circulated in this city by the Marshalltown Electric Street & Interurban Railway Company, to be presented to the City Council, to call a special election to decide whether or not a 3-per-cent. tax shall be levied for the purpose of aiding the construction of an interurban line from Marshalltown to Grundy Center. The company asks the payment of one-half of the tax when the line is completed from Marshalltown to Grundy Center and the other half one year later. J. G. White & Company, of New York, are understood to be considering a proposition to build the line.

GREENVILLE, LA.—The City Council has granted the concessions asked by the Delta Light and Power Company for the extension of its tracks. It was decided at a meeting that if this city and Leland would donate or subscribe $50,000 of stock the company would extend the line to Leland, which is about 12 miles from Greenville.

ANNAPOLIS, MD.—A "Jim-Crow" bill for the electric cars of the whole State has been introduced in the House.

BAY CITY, MICH.—The Bay City Traction & Electric Company will install a storage battery plant in the building on Water street now used as office quarters.

FARIBAULT, MINN.—Hon. Donald Grant, of this place, has under consideration the building of an electric railway here.

MINNEAPOLIS, MINN.—The Minnesota Power & Trolley Company has been advised from Washington that the President has signed the bill permitting the construction of a dam across the Mississippi River, 2 miles above Elk River and without requiring the installation of a lock.

DULUTH, MINN.—Articles of incorporation of the Lake Superior & Northern Railway Company have been filed. The incorporators are: L. R. Martin, who is president and treasurer; H. P. Gardiner, vice-president and secretary; H. B. Fryberger, H. C. Fulton and M. A. Armstrong. The company is capitalized at $50,000, while its limit of indebtedness is $5,000,000. The purpose of the corporation is to construct and operate railway lines in this state and elsewhere, build telephone and telegraph lines, carry on a freight and passenger business and acquire right of way, depot grounds and freight yards.

JEFFERSON CITY, MO.—The Forest Park & Richmond Heights Railway Company has been chartered to build a branch line one mile long from St. Louis City to Richmond Heights, and has a capital of $25,000. The stockholders are: N. E. Niesen, Robert Rutledge, James McCausland, Charles J. Roberts and Bernard Christian.

ST. JOSEPH, MO.—The St. Joseph Interurban Railway Company filed articles of incorporation March 22. Its capital stock is $100,000. The incorporators are: George C. Sims, of Des Moines, Iowa; A. C. Plummer, of Altoona, Iowa; Alice M. Butler, John C. Landis, Jr., of St. Joseph. The company will build an electric railway from Savannah to Platte City, through St. Joseph.

ALBANY, N. Y.—The Assembly Railways Commission has decided to report favorably the Wallace third-rail protection bill. It requires companies operating third-rail lines to cover or in some way guard the third rail, so that persons will not run risk of injury from it. The elevated roads in New York City are, of course, the main ones affected by the bill.

ELMIRA, N. Y.—A certificate of incorporation has been filed in the office of the Secretary of State for the Elmira & Corning Short Line. Among the directors named are: Joseph Powers, of Troy; G. Tracy Rogers, of Binghamton; William R. Compton, of Elmira; A. Lee Smith, of Elmira. It is understood that the Powers & Mansfield Company has made the surveys and is actively connected with the enterprise. The length of the line to be built is about 13½ miles from the city limits of Elmira into the city of Corning, and that of this distance 12½ miles is upon private right of way. It is proposed to equip the line with a protected third rail.

CLEVELAND, OHIO.—The Lake Shore Electric Railway Company, Cleveland, Ohio, has placed a contract with the Aermotor Company, Chicago, for two structural steel towers to be used in carrying high tension circuits over Black River, Lorain, Ohio.

TOLEDO, OHIO.—Stockholders of the Toledo & Indiana Railway Company and the Toledo, Hicksville & Fort Wayne Railway Company, which is affiliated with the first mentioned, will meet April 5 to consider a proposition to extend the Toledo & Indiana Railway to Fort Wayne by way of Defiance.

CORTLAND, OHIO.—C. G. Phillips, general manager of the Warren, Cortland & Jefferson Traction Company, states that preliminary surveys for the road have been completed, and that the work of grading will be started at once. Engineers of the Westinghouse Electric & Manufacturing Company have suggested that a large power house be erected at Kinsman to supply power for this line as well as the Cleveland & Sharon Traction Company, which is being built by the same interests.

GUTHRIE, OKLA.—A charter has been issued to the Oklahoma City, Lexington & Sulphur Springs Electric Railway Company, of Lexington. The capital stock is $1,000,000. The stockholders are: Charles Stewart, of Parkersburg, W. Va.; J. S. Little, H. L. Forehand, E. Duffy, W. J. Reed, E. J. Keller, R. E. Thacker, G. A. Teague, A. Hutchins, E. P. Mosely, Jay Sherman, of Lexington.

SCRANTON, PA.—The directors of the Scranton Railway Company have authorized an outlay of $300,000 for improvements to the system.

FRANKLIN, PA.—A company, with $400,000 capital, has been formed in Pittsburg to build a 53-mile electric railway between Franklin and Butler, where connection will be made with a line between Pittsburg and Butler, now approaching completion.

YORK, PA.—It is stated that the capital stock of the York County Traction Company is to be increased from $1500 to about $5,000,000, preparatory to the building of new lines in this county. Lines are planned to run to Hanover, Dillsbury, Lewisberry, Yorkana, Airville, Brogneville, Collinsville and Delta.

PHILADELPHIA, PA.—Plans have been approved by the Board of Surveyors for double tracks for the Philadelphia Rapid Transit Company on Twenty-ninth street, from Lehigh avenue to Allegheny avenue. The line will be a connecting branch of the Lehigh and Allegheny avenue lines.

MECHANICSBURG, PA.—The Cumberland Valley Electric Passenger Railway Company will be offered for sale on June 25, under foreclosure brought by the Harrisburg Trust Company, trustee. The successful bidder will have to pay $25,000 cash on the spot when the sale is declared, and the balance of the purchase money must be forthcoming on July 1.

LEWISTOWN, PA.—The Lewistown & Reedsville Electric Railway Company contemplates important improvements. Contracts have been awarded to P. E. Lane & Co., of Atlantic City, N. J., for the extension of the line from the present terminus to the Pennsylvania Railroad station at Lewistown Junction.

HARRISBURG, PA.—A charter has been granted at the State Department to the Inter-State Electric Railway Company, capital $200,000, to build a 20-mile line from the intersection of Vine and Main Streets, Port Allegheny, McKean County, through the towns of Burtonville, Roulette, Mina and Coudersport, Potter County. The directors are: L. B. Seibert, of Coudersport, president; H. H. Cobb, F. L. Andrews, M. L. App, D. S. Seibert, W. T. Church, H. A. Avery.

LEAD, S. D.—An electric railrway, fifty miles long, will be built this spring connecting Lead with the coal mines of northeastern Wyoming.

BELTON, TEX.—Arthur C. Kretz, of Reading, Pa., engineer for the proposed Temple-Belton Interurban Electric Railway, is here making a preliminary investigation of the route of the proposed road.

WACO, TEX.—A movement has been inaugurated looking to the construction and operation of an interurban electric railway between this city and Dallas, by way of Hillsboro and Waxahachie. Colonel James B. Baker, of Waco, is interested in the project and can give information.

BELLINGHAM, WASH.—Specifications have been ordered by the City Council for a municipal electric lighting plant to be operated by the power of Whatcom Falls.

COLFAX, WASH.—The County Commissioners have granted the franchise for an electric railway asked for by S. J. Crutcher, A. J. Smith and associates of Pine City, through the north part of Whitman County to Colfax. The promoters purpose building a line from Spokane via Spangle, in Spokane County, to Pine City, in Whitman County, thence via St. John to Colfax.

ST. ANSELME, QUE.—The Ste. Claire Electric Company is considering the construction of an electric railway through the counties of Dorchester, Bellechasse and Levis.

TORONTO, ONT.—Notice is given that application will be made to the Parliament of Canada, at its next session, for an act incorporating a company under the name of the Nipissing, Ottawa & Montreal Railway Company, with power to construct a line of railway from a point at the east end of Lake Nipissing to the city of Montreal, and also a line extending from said point along the north side of Lake Nipissing and French River to a point on Georgian Bay, and to acquire, own and operate water power and generate electric power for lighting and motive purposes.

NEW INDUSTRIAL COMPANIES.

THE INSULATED COPPER COMPANY, of Islip, N. Y., has been incorporated with a capital of $25,000. Directors: W. K. Post, R. D. Upham and H. B. Johnson, New York.

THE BAXTER LIGHTING COMPANY has been incorporated at Camden, N. J., with a capital of $25,000. Incorporators: Lewis F. Baxter, George M. De Gunther and L. Howard Weatherby.

THE MARINE MAGNETIC CONTROL COMPANY, of New York, has been incorporated; capital, $100,000. Directors: J. O. Stevens, Plainfield, N. J.; Albert Graham and Edward Pfuhler, New York.

THE COLONIAL ENGINEERING COMPANY, of New York, has been incorporated; capital, $1000. Directors: T. J. Kane, New Brunswick, N. J.; J. A. C. Johnson, Englewood, N. J., and W. C. Furley, Brooklyn.

THE ELECTRIC AND STEAM ENGINEERING COMPANY has been incorporated at St. Louis, Mo. The capital stock is $5000, full paid. The incorporators are B. D. Kribben, W. J. Burton, E. R. Suits and R. H. Moore.

THE TOWER STORAGE BATTERY COMPANY, Cleveland, O., capital stock $10,0000, has been incorporated by E. B. Robbins, T. Rowland, C. A. Gilbert, G. D. Reed and J. H. Van Derveer. The company will manufacture automobile batteries.

THE FARIBAULT MANUFACTURING COMPANY has been organized at Faribault, Minn., for the manufacture of dynamos, motors and gasoline engines. Active operations have already commenced. Hon. Judge James Hunter is vice-president of the company.

LEGAL.

WIRELESS TELEGRAPH LITIGATION.—Judge Lacombe in the United States Circuit Court, New York City, on March 30, denied an application for a preliminary injunction against the De Forest Wireless Telegraph Company and others in proceedings instituted by the National Electric Signalling Company for alleged infringement of patent. The application sought to restrain the De Forest company from using certain apparatus to which the National Company claims exclusive rights, chiefly the liquid barretter patented by Prof. Reginald A. Fessenden, an instrument for receiving Hertzian waves. The De Forest company was represented by Cornelius D. Ehret, of Philadelphia, and Francis X. Butler, and the National Electric Signalling Company by Kenyon & Kenyon. Judge Lacombe, in his opinion, did not pass on the merits of the case, simply stating that the question at issue should be left for final hearing.

OBITUARY.

CHARLES J. POWER, a well-known telegrapher, died at his home in New York City, March 21. At the time of his death he was chief operator in the Commercial News Department of the Western Union Telegraph Company, at 195 Broadway. Deceased was 43 years of age.

EDUCATIONAL.

LEHIGH UNIVERSITY.—The Register of Lehigh University, South Bethlehem, Pa., just issued, copies of which may be had on application, shows the attendance of 615 students from 24 States and 10 foreign countries, of whom 90 are taking the course in electrical engineering. There are 54 in the teaching staff. Thirteen four-year courses of instruction are offered at the University: the classical course, the Latin-scientific course, the courses in civil, mechanical, marine, metallurgical, mining, electrical, and chemical engineering, analytical chemistry, geology, physics, and electrometallurgy. A list of graduates of the University, 1304 in number during the 38 years of its existence, indicates that this institution is exerting a very marked influence on the industrial development of the United States, and also of foreign countries. Provision is made for worthy and needy students whereby they may postpone payment of tuition until after graduation.

UNIVERSITY OF WISCONSIN, SUMMER SCHOOL FOR ARTISANS.—The fourth annual sessions of the Summer School for Artisans, held under the direction of the College of Engineering of the University of Wisconsin, begins June 27, and continues for a period of six weeks. Courses of study are offered in the following subjects: (1) Steam, Gas and Other Heat Engines. (2) Applied Electricity. (3) Mechanical Drawing and Machine Design. (4) Materials of Construction, Fuels and Lubricants. (5) Shop Work. Three sessions of this school have been held. The first, in 1901, marked a new departure in educational methods and was begun as an experiment, but its success has justified the continuation of these sessions. In 1903 students came from twelve states, and among them were representatives of the following occupations: Machinist, electrician, draftsman, stationary engineer, erecting engineer, chief engineer of electric plant, carpenter and manual training teacher. The class instruction consists of lectures given by members of the regular faculty of the College of Engineering, and as the entire laboratory equipment of this college is available for instruction in the school, opportunities are thus afforded for laboratory practice, otherwise available only in a regular engineering course. A large number of the students enrolled have had correspondence instruction. The requirements for admission do not extend beyond a working knowledge of English and arithmetic, but the policy is to allow a large amount of individual work so that the student may take advantage of all the preparation he has obtained. As the demand renders it necessary, advanced courses will be established in the various subjects.

PERSONAL.

MR. PAUL JONES has been appointed secretary and treasurer of the Lincoln, Neb., Gas & Electric Light Company. He was formerly connected with the Denver Gas & Electric Company as its accountant.

MR. W. E. GILMORE, the active manager of the Edison Mfg. Co., and several other Edison enterprises at Orange, N. J., leaves this week on a trip to Europe to look after various important matters there in Mr. Edison's behalf.

MR. BENJAMIN H. BLOVER, formerly with the Underwriters' Laboratories and the past year engineer of the Chicago Fuse Wire & Mfg. Co., at Buffalo, N. Y., is now associated with the Westinghouse Electric & Mfg. Co., at East Pittsburg, Pa.

MR. THOMAS B. BAILEY'S election to the directorate of the American Telephone and Telegraph Company to fill the vacancy caused by the death of J. Malcomb Forbes is said to be but a temporary one. Mr. Bailey has his hands full as purchasing agent of the company.

MR. C. J. H. WOODBURY recently addressed the Worcester, Mass., Board of Trade on the "Telephone System of To-day." He fully described the modern telephone system and its operation, the subject being illustrated by over 100 lantern slides.

MR. M. J. FRANCISCO, of Rutland, Vt., past president of the National Electric Light Association, has been confined to his bed for seven weeks past with a severe attack of pneumonia. He is recovering, but it may be some weeks before he is able to resume active duties.

MR. P. G. GOSSLER has resigned his position as general superintendent and engineer of the Montreal Light, Heat and Power Company, to take effect May 1. He has accepted the general managership of the operating department of J. G. White & Co., of New York.

MR. A. C. RAHE, manager of the Smith Storage Battery Company, of Binghamton, N. Y., was in New York last week. Not only was he interested at the time in storage batteries for special lines of work, but he had in mind some other lines which promise important and interesting developments.

MR. W. B. POTTER, chief engineer of the electric railway department of the General Electric Company, has returned from a recent trip to the West Indies, whither he went to rest and recuperate after a severe attack of overwork and grip. He has benefited greatly by the holiday in summer seas.

MR. EDWIN W. RICE, JR., has been elected during the past week a director of the General Electric Company to fill the place left vacant by the death of William C. Whitney. Mr. Rice is a director in several street railway and electric lighting companies, and is already a vice-president of the General Electric Company.

MR. E. C. HURD, president of the proposed electric railway from Omaha to Beatrice, has completed plans and has come on to New York to finance the undertaking. Before leaving, he arranged with the Omaha & Council Bluffs Street R. R., which owns all Omaha electric lines, to permit the use of its tracks as soon as the new line is completed.

MR. C. H. HINES, electrical engineer of the mechanical department of the Canadian Pacific Railway, is at Fort William, Canada. The Canadian Pacific announces that it will build a large central power house at Fort William and equip it with two 750-hp engines, to be used to generate current to drive all the machinery in the big grain elevators, as well as coal-handling machinery.

DR. F. A. C. PERRINE.—The Clarkson School of Technology has just reprinted in pamphlet form, as part of its *Bulletin*, Dr. Perrine's admirable Founder's Day Address, "The Success of the Educated Man." He claimed that the modern "humanities" are really the great engineering arts, and that the work of the educated engineer has elevated the entire world up to more pleasant places for mankind to live in.

MR. C. C. STARR.—The Canadian Westinghouse Company, Ltd., of Hamilton, Canada, has recently engaged Mr. C. C. Starr, who was formerly connected with the firm of John Starr, Son & Company, to act as its representa- in the maritime provinces, with headquarters at 134 Granville street, Halifax, N. S. The maritime provinces are included in the district of the Canadian Westinghouse Company's Montreal office, and Mr. Starr will be consequently an attaché of that office.

MR. R. M. BARWISE, well known in the electric automobile and incandescent lamp fields, is returning to New York from Philadelphia and will carry on for the Pope Mfg. Co. on upper Broadway, a handsome garage and show room for Pope Waverly electrics. Mr. Barwise, in addition to considerable executive force, and electrical knowledge, combines a close familiarity with the bicycle and automobile arts, and a host of old friends welcome him under his new connections with Col. Pope and Mr. E. Mason.

MR. W. W. WHEATLEY.—We learn that Mr. W. W. Wheatley, who was for a time superintendent of the trolley system of the Brooklyn Rapid Transit Company, has gone to Mexico, where he is to assume charge of the electric railway system of the City of Mexico. Mr. Wheatley sailed last month to take up his new work. It is said that his salary is to be $15,000 a year in gold. The Mexican road is owned by Wernher, Beit & Company, of London. Mr. Wheatley was with the Brooklyn Rapid Transit Company for two years. He then became general manager of the Public Service Corporation in New Jersey, but remained less than a year under extremely exacting and trying conditions.

MR. EDWARD WESTON, of Newark, N. J., has had conferred upon him the degree of LL.D. by McGill University, of Montreal, Canada, in recognition of his inventions and investigations in electrical science. It is appropriate that this well-deserved acknowledgment should come from Canada, and from one of the most progressive seats of learning under the British flag, and one where moreover electricity has received special attention. Mr. Weston has been an American citizen a great many years, and all his notable work has been done in this country, but he is an Englishman by birth, and in many of his attributes. He studied medicine originally, and first took up electro-

chemistry. He was president of the American Institute of Electrical Engineering in 1888.

MR. W. F. BAKER has been appointed contract agent of the New York Telephone Company in succession to Mr. F. H. Bethell, promoted to the management of the Potomac Telephone Company, with headquarters in Washington. Mr. Baker has been 6½ years with the department, and for the last two years special agent for the Dey street division. He is a graduate of Harvard University, class of '93, and is a native of Springfield, Mass. He was at one time in the insurance business, and was also city editor of the *Springfield Union*, one of the leading newspapers of New England. Although the company has to-day no fewer than 140,000 subscribers in connection or under contract for service, Mr. Baker believes enthusiastically in the possibilities of great growth and extension in the metropolitan territory.

MR. HARMAN S. SALT has been made manager of the Dale Company, of New York City, and assumed his new duties on April 1 at headquarters in the Hudson Street factory. Mr. Salt, although quite a young man, has had a long and successful career in the field of electrical manufacturing. He entered the service of the Western Electric Company, in New York City, in 1887. He displayed executive ability from the start, and in 1891 was put at the head of the export department, in which during the past thirteen years he made a most creditable record. For a time he was also out on the Pacific Coast for the Company, with beneficial results to its affairs there. Mr. John Dale in his growing business in lighting fixtures and specialties has therefore enlisted experience and ability, in Mr. Salt, that will prove extremely valuable.

MR. J. W. LATTIG.—At its offices, 112 North Broad street, Philadelphia, the employees of the United Telephone & Telegraph Company, as well as the officers of the York State Telephone Company, the officers of the Eastern Electrical Construction Company and the officers of the Eastern Telephone Manufacturing Company, with whom he has held business relations, presented last week to the retiring general superintendent, Mr. J. W. Lattig, a handsome dinner set of 150 pieces, and a beautiful cut glass water set. Mr. Lattig has been with the United Telephone & Telegraph Company for two and one-half years and during that time, as shown by the handsome gift, he has earned the good-will and earnest co-operation of everybody from the officers of the company on down. Mr. Houck, the traffic manager, made the presentation in a neat speech, to which Mr. Lattig replied briefly and feelingly. Mr. Lattig's resignation as general superintendent of the company went into effect on April 1, when he assumed new duties with the Delaware & Atlantic Telephone & Telegraph Company.

HON. S. N. D. NORTH, director of the U. S. Census Bureau, contributes to the *Annals of the American Academy* an interesting article showing how, under the protective tariff, American manufacturers have grown so strong that they have now only invaded foreign markets but penetrated to foreign soil as a foothold. He cites a number of examples and says: "The Western Electric Company, of Chicago, is interested in extensive factories in London, Paris, Antwerp and Berlin, not all of them carried under the name of that company, but all of them established and controlled by its capital. The General Electric Company has three or four such establishments, and has recently constructed a huge new factory at Rugby, in England. The Westinghouse Company has just finished, at Trafford Park, in England, one of the largest electric factories in Europe, employing two or three thousand men, and it has other factories in Havre, France, and St. Petersburg, Russia. The Singer Machine Company has three large plants in Europe, under its direct control. The Chicago American Tool Company is building a plant at Frazerburg, near Aberdeen. The Hoe printing presses are made in London, as is also American linotype machinery. The Draper Company has recently completed its new factory in Lancashire, to supply the greatest cotton-manufacturing district of the world with the American fast-running Northrup loom. This list might be extended indefinitely, and a fine field for investigation is opened for the full measurement of this remarkable transplantation."

Trade Notes.

MR. A. C. LIPPINCOTT, 109 Franklin Avenue, Scranton, Pa., will be glad to send to any engineer a fine catalogue of indicators, reducing wheels, planimeters, steam separators, etc., by addressing him as above.

PITTSBURG TRANSFORMERS.—The Pittsburg Transformer Company has issued a little folder giving some suggestive facts about these well-known transformers. The folder is accompanied by an attractive calendar for April. The picture is that of a pretty girl, presumably one of those referred to in the folder.

AUTOMATIC TELEPHONE EXCHANGES.—In a pamphlet of 32 pages issued by the Automatic Electric Company of Chicago are given copies of many letters received from patrons of the Home Telephone Company of Dayton, Ohio, testifying to the satisfactory service rendered by the automatic exchange in that city. An illustration of the Dayton automatic exchange is given, which shows a very extensive equipment.

THE NATIONAL-ACME MANUFACTURING COMPANY, Cleveland, Ohio, maker of the Acme multiple spindle automatic screw machine, does a large trade in special work for manufacturers of electrical apparatus. These specialties include set screws, cap screws, machine screws and milled work turned from steel, iron, zinc and brass. The company has recently issued an attractive monthly calendar, which gives a view of one of its machines.

"BURIAL EXPENSES" is the title of a folder issued by the Ewing-Merkle Electric Company, 1006 Pine Street, St. Louis, Mo., on the subject of the Stombaugh guy anchor. The title is rather funereal, but the subject is a living one to telephone men, who are eternally confronted with the problem of guying poles. The Stombaugh anchor meets such cases very completely. It screws into the ground and affords an anchorage that is steadfast and good for all time.

STEAM HAMMERS.—The David Bell Engineering Works, Buffalo, N. Y., has issued a very complete catalogue devoted exclusively to steam hammers. This company makes a specialty in 10 sizes, from 250 lbs. to 1600 lbs. falling weight. These hammers are in use in practically every part of the country and in foreign countries as well, and their field of use is constantly increasing. They are especially adapted to the use of manufacturers of electrical machinery. The catalogue fully describes and illustrates these hammers, and gives all the dimensions of each.

NATIONAL ALTERNATORS.—The National Electric Company, Milwaukee, Wis., has recently issued a 40-page pamphlet on the subject of its alternating-current machinery for lighting, power and railway service. The National Company has developed a line of revolving field alternators up to 1500 kw capacity. These machines represent the latest development of engineering design, and both the mechanical and electrical features have been carefully worked out. Their construction and features are completely described and clearly illustrated. Tables and diagrams at the back give the principal dimensions of the machines of the various types.

A HANDSOME CALENDAR, quarto size, has been issued by the Stromberg-Carlson Telephone Manufacturing Company, of Chicago and Rochester, N. Y. It shows a beautiful girl in evening dress sitting at a desk telephone set of the company's make, receiving very pleasant news, transmitted evidently with very distinct articulation. A special feature is the fact that the picture is not a "half-tone," but a real photograph. At the side is a large rose spray with the flowers and leaves in natural colors. The monthly calendar slips are detachable. Copies of this artistic calendar can be had on application by the heads of telephone operating companies, the request to be accompanied with 10 cents for mailing.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MARCH 29, 1904.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St. N. Y.]

755,054. SERVICE-METER FOR TELEPHONE-LINES; Charles E. Scribner, Chicago, and Frank R. McBerty, Evanston, Ill. App. filed April 2, 1900.

755,127. ELECTRIC SELECTIVE SYSTEM; Juliene Auguste Géhrung, St. Louis, Mo. App. filed February 8, 1902.

755,308. SERVICE-METER FOR TELEPHONE-LINES; Frank R. McBerty, Evanston, Ill. App. filed July 16, 1900.

755,515. COUNTING SYSTEM FOR TELEPHONES; Johann Heinrich Meyer, Madgeburg, Germany. App. filed May 26, 1902

755,630. BELL; William W. Dean, Chicago, Ill. App. filed March 24, 1902.

755,642. ELECTRIC ACCUMULATOR-PLATE; Chaimsonovitz Prosper Elieson, Paris, France. App. filed Oct. 16, 1903. (See Current News and Notes.)

755,643. PROCESS OF MAKING ELECTRIC ACCUMULATOR-PLATES; Chaimsonovitz Prosper Elieson, Paris, France. App. filed Oct. 16, 1903. (See Current News and Notes.)

755,646. MULTIPLEX TELEGRAPHY; Stephen D. Field, Stockbridge, Mass. App. filed March 5, 1903. Current reversals and currents of different strength are transmitted by a single mechanism so arranged as to act without interference and in transmitting the reversals the potentials are altered by a series of steps between the maximum of one polarity and that of the opposite, thus making it easier to "balance" the system. Two other transmissions are superposed upon the first two by giving different frequencies to a vibratory key.

755,647. MULTIPLEX TELEGRAPH; Stephen D. Field, Stockbridge, Mass. App. filed March 24, 1903. Improvements upon the preceding invention.

755,659. ELECTRIC WATER HEATER; James F. Hathaway, San Francisco, Cal. App. filed Aug. 10, 1903. A handle having a heater attached thereto and adapted to be plunged into a vessel of water.

755,669. CURRENT SELECTOR FOR CHARGING SECONDARY BATTERIES; Miller R. Hutchison, New York, N. Y. App. filed May 5, 1903. An electrolytic cell adapted to permit the flow of current in one direction but to prevent it in the opposite direction, is placed in circuit with the battery and a lamp for charging purposes, the lamp showing when the current is flowing to the battery.

755,697. ELECTRIC INCANDESCENT LAMP SOCKET; Guy H. Proctor and John B. Daley, Somerville, Mass. App. filed 30, 1903. Details.

755,708. HIGH OR LOW PRESSURE SIGNAL ALARM; Frank H. Schmitz, New York, N. Y. App. filed Sept. 4, 1903. A plunger is forced upward by the fluid pressure and closes a circuit at a critical point.

755,731. CONTROLLER FOR ELECTRIC MOTORS; Magnus W. Alexander, Lynn, Mass. App. filed June 13, 1903. When current fails or drops below a certain strength, the contact arm of the controller is automatically disconnected from the hand lever and returned to its off-position.

755,732. ELECTRIC MOTOR; Ralph E. Barker, Lynn, Mass. App. filed Aug. 7, 1903. The weight of the field coil is sustained upon lugs projecting from the head castings of an incloscd motor.

755,739. MAXIMUM DEMAND INDICATOR; Harry W. Brown, Boston, Mass. App. filed Aug. 2, 1902. The indicator comprises a conductor which is magnetic at low temperatures but non-magnetic at high temperatures; a variation of magnetism causes an indication on a scale.

755,740. SYSTEM OF ELECTRICAL DISTRIBUTION; Harold W. Buck, Niagara Falls, N. Y. App. filed Sept. 4, 1902. A motor generator set having means for regulating the voltage on the alternating current system in response to variation of load on the direct current system.

755,743. REMOVABLE CONTACT FINGER TIP; Frank E. Case, Schenectady, N. Y. App. filed July 9, 1902. The tip is separate from the finger and formed to be readily attached and detached.

755,744. CONTROLLER; Frank E. Case, Schenectady, N. Y. App. filed Oct. 1, 1902. An elongated coil is arranged across the face of a controller drum so that its field of force includes all of the arc gaps, a single coil thus serving to disrupt arcs at any point on the controller.

755,757. MULTIPLE RATE METER; Alexander J. R. Fiego, Lynn, Mass. App. filed July 21, 1903. Two dial-trains are alternately connected with the meter-motor by electro-magnets whose circuits are closed by a clock.

755,766. TRANSFORMER; Walter A. Hall, Lynn, Mass. App. filed Sept. 29, 1902. A transformer core consisting of oppositely disposed bundles of iron laminæ arranged radially to fill the center of the core with a mass of laminated iron polygonal in cross-section to form cooling spaces in the periphery of the center of the core.

755,771. ELECTRIC SWITCH OR CIRCUIT BREAKER; Edward M. Hewlett, Schenectady, N. Y. App. filed Jan. 29, 1900. Mechanism for operating the circuit breaker from a point of safety to the operator.

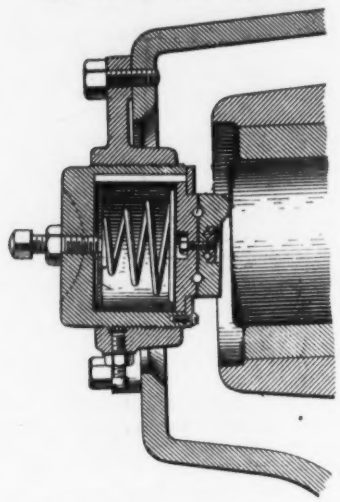
755,772. SWITCH; Edward M. Hewlett, Schenectady, N. Y. App. filed Aug. 14, 1903. Means for closing the field circuit of a generator through a resistance shunt, comprising a snap switch and an auxiliary shunt terminal on which said switch closes just before opening the armature circuits.

755,774. ELECTRIC CLOCK; Frank Holden, London, England. App. filed April 16, 1900. Details.

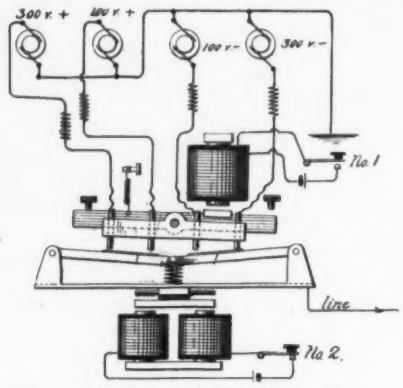
755,775. SYSTEM OF ELECTRICAL DISTRIBUTION; Lewis L. Holladay, Lynn, Mass. App. filed Aug. 21, 1902. A plurality of secondary coils on a transformer, one feeding a circuit with lagging current and the other feeding a consumption circuit with leading current.

755,782. ELECTRICAL CONTACT DEVICE; John Lindall, Boston, Mass. App. filed Oct. 8, 1903. A third-rail contact shoe consisting of a box-shaped piece of metal resting at its extremities against a leaf spring to prevent free movement or rattling.

755,783. ELECTRIC FIRE ALARM; August Lueckert, St. Louis, Mo. App. filed Dec. 10, 1902. Details.



755,787—End Play Device for Rotary Machines.



755,646—Multiplex Telegraphy.

755,825. RAILWAY BRAKE APPARATUS; Granville T. Woods and Lyates Woods, New York, N. Y. App. filed Dec. 31, 1902. The invention comprises various ways of bringing a train to a stop, controllable either by the motorman, or self-acting in case he is disabled; or by a passenger, or by a flag-man at the roadside.

755,827. RHEOSTAT; William C. Yates and Paul Zimmer, Schenectady, N. Y. App. filed July 25, 1903. A rheostat by which resistance may be cut into a circuit in large steps until near the desired amount and any large step then graduated by small steps for more exact regulation.

755,828. RHEOSTAT; William C. Yates, Schenectady, N. Y. App. filed Aug. 22, 1903. Details.

755,829. CONTROLLING INDUCTION MOTORS; Arnaldo P. Zani, Milan, Italy. App. filed June 30, 1900. (See Current News and Notes.)

755,830. TUB FOR ELECTRIC BATHS; Joself Zwiebel, Neu-Ulm, Germany. App. filed Nov. 24, 1903. Rods supporting the electrodes have insulated portions to which the electrodes can be transferred to alter the number in circuit and accordingly the direction and strength of the current.

755,840. DETECTOR FOR ELECTRICAL DISTURBANCES; Jagadis Chunder Bose, Calcutta, India. App. filed Sept. 30, 1901. (See Current News and Notes.)

755,853. ELECTRIC-POWER-TRANSMISSION SYSTEM; Max Deri, Vienna, Austria. App. filed May 28, 1902. (See Current News and Notes.)

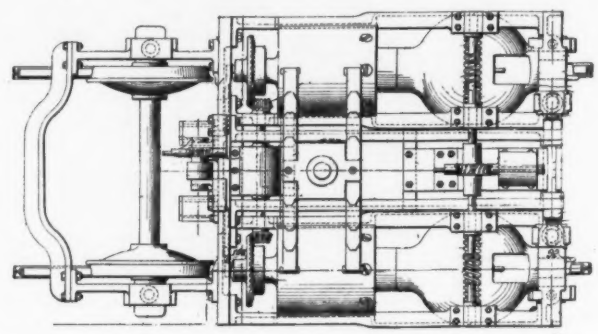
755,889. ELECTRIC RAIL BOND; Jang Landsing, Brooklyn, N. Y. App. filed April 25, 1900. A strap of metal slitted into narrow strips between its extremities, the strips being bent at succeeding points to afford the necessary flexibility.

755,890. ELECTRIC SIGNALING DEVICE; Thomas C. Laney, Toledo, and Charles S. Longnecker, Delta, Ohio. App. filed Nov. 24, 1902. Details.

755,897. ELECTRIC LOCK; Frank Lombardi, Brooklyn, N. Y. App. filed Dec. 19, 1903. Details.

755,899. ELECTRIC RAILWAY SYSTEM; Timothy Mahoney, San Francisco, Cal. App. filed April 20, 1903. Details.

755,905. ELECTRIC TRACTION SYSTEM FOR RAILWAYS; August Meuschel, Montreal, Canada. App. filed May 4, 1903. The driving means instead of being cylindrical like car wheels, are spherical in form and rotate in variable planes, parallel to the line of motion of the car, so that the effective diameter of the driver can be altered without altering the speed of rotation of the driver.



755,905—Electric Traction System for Railways.

755,791. MEANS FOR CLOSING FIELD CIRCUITS OF ROTARY CONVERTERS; William B. Potter, Schenectady, N. Y. App. filed Sept. 17, 1903. By means of a polarized armature the proper polarity of the armature brushes at the instant the field is connected to them, is ensured and by a proper adjustment of a spring the voltage at which the field circuit will be closed can be adjusted, thus the danger arising from closing a field circuit at the wrong instant is avoided.

755,793. STARTING DEVICE FOR INDUCTION MOTORS; Henry G. Reist and Arthur W. Henshaw, Schenectady, N. Y. App. filed June 27, 1902. The invention consists of a motor starting device comprising a starting switch having contacts carried by the rotable member, and an operating mechanism, arranged to give a step-by-step movement to the switch in one direction, the mechanism being also arranged to permit a continuous movement in the reverse direction.

755,796. FUSIBLE CUT OUT; Howard R. Sargent, Schenectady, N. Y. App. filed March 14, 1900. A fusible strip is placed in an air-tight strong cartridge, otherwise empty, so that the gases evolved by the blowing of the fuse will not destroy the cartridge.

755,797. ARC LAMP HANGER; Howard R. Sargent, Schenectady, N. Y. App. filed Sept. 2, 1902. An automatic hook which engages when the lamp is lifted and disengages by a slight upward movement.

755,800. TRANSFORMER; Louis M. Schmidt, Lynn, Mass. App. filed Sept. 19, 1902. A transformer having portions of its core extended beyond the body of the transformer to form supporting feet and a winding surrounding the core except near the feet, the terminals being brought out in the unwound space.

755,814. COUPLING ELECTRIC MOTORS; David P. Thomson, Rugby, England. App. filed Sept. 8, 1903. Unison running is accomplished by connecting corresponding fixed points in the armature winding by equalizing connections of such a character that only equalizing current will flow through them.

755,815. ELECTRIC ARC LAMP; Elihu Thomson, Swampscott, Mass. App. filed Aug. 19, 1901. A self-induction coil in series with the arc, a polarized armature connected with a movable carbon and a closed coil operating to assist the movements of the armature.

755,819. INDUCTION MOTOR; Pendleton G. Watmough, Schenectady, N. Y. App. filed Sept. 2, 1902. The stator has a two-part ring-core over which the coils are slipped and then an externally slotted ring is passed into the ring-core so that its slots will embrace the sides of the coils and produce, in effect, a "tunnel" winding.

755,822. TRAIN CONTROL SYSTEM; George Whittlesey, Washington, D. C. App. filed Sept. 26, 1902. A multiple train control system in which the standard car controllers are utilized and the number of train wires reduced to four.

755,824. MEANS FOR STARTING ALTERNATING CURRENT DYNAMO ELECTRIC MACHINES; Jonathan E. Woodbridge, Schenectady, N. Y. App. filed Sept. 11, 1901. Comprises means whereby an electro-motive force of gradually increasing frequency can be impressed upon the machine to be started and also means whereby the field of a machine can be excited by a direct current.

755,954. ELECTRIC LAMP AND SOCKET; Albert N. Soden, Trenton, N. J. App. filed Dec. 10, 1902. The lamp is an inverted cone in shape and has an outer transparent wall and in inner reflecting wall, a number of filaments embracing the latter and being singly or jointly insertable in the circuit by a suitable switch.

755,999. ELECTRIC TROLLEY HEAD; John T. Cherry, Plymouth, and Edward H. Clive, Devonport, England. App. filed Nov. 3, 1902. Details.

756,025. ELECTRIC LIGHT CIRCUIT PROTECTOR; Stanley Kalbach, Wildwood, N. J. App. filed May 12, 1902. Details.

756,026. INSULATOR; William S. Kinsley, Stewart S. Bell, Reading, Mass. App. filed Aug. 10, 1903. A two-part block carrying the conductor between them and held together by a binding wire, the block being supported by a bail having a threaded shank.

756,045. SHUNT CONTROLLER FOR ELECTRIC MACHINES; Nels O. Nelson, Chicago, Ill. App. filed July 13, 1903. The output of a frictional generator is controlled by means for forming a shunt circuit between inductor bars arranged adjacent to the collecting combs.

756,049. SWITCH FOR INCANDESCENT ELECTRIC LAMPS; Conrad M. Pitel, Meriden, Conn. App. filed Nov. 23, 1903. A switch designed for hanging lamps.

756,050. COUPLING FOR INCANDESCENT ELECTRIC HANGING OR SUSPENSION LAMPS; Conrad M. Pitel, Meriden, Conn. App. filed Nov. 23, 1903. Details.

756,091. TELEPHONE-CABINET; William B. Altick, Lancaster, Pa. App. filed May 16, 1902. (See next week's issue.)

756,117. ELECTRIC LAMP SUPPORT FOR CONVERTIBLE SIGNAL LANTERNS; Louis H. W. Kerber, Chicago, Ill. App. filed May 13, 1903. A framework arranged to receive either an electric or an oil lamp.

756,119. ELECTRIC RESISTANCE; Hans Von Kramer, Bath, England. App. filed Sept. 1, 1903. Details.

756,156. SIGNAL APPARATUS FOR TROLLEY RAILWAYS; Almo L. Cheatham, Louisville, Ky. App. filed Aug. 8, 1903. A contact arranged to be touched by the trolley wire when it lifts the main conductor in passing.

756,167. CONTROLLING ELECTRIC BOOSTERS; Edward M. Hewlett, Schenectady, N. Y. App. filed Oct. 20, 1902. An auxiliary booster is provided and adapted to be inserted in place of an incapacitated booster feeding any one of a number of circuits.

756,176. PROTECTIVE SHEATH OR ENVELOP FOR STORAGE-BATTERY PLATES; Achille Meygret, Paris, France. App. filed March 29, 1904. (See Current News and Notes.)

756,181. INSULATOR; Louis McCarthy, Boston, Mass. App. filed Feb. 11, 1904. Oppositely placed metallic portions connected by a piece of insulating material and surrounded by a molded insulating composition, the latter being formed with a number of petticoat edges.

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FOR CARD INDEX

ELECTRICAL WORLD AND ENGINEER APRIL 2, 1904

Tesla Split Phase Motor Patent Decision	634
Discussion of Institute Papers	634
Simultaneous Telephone and Telegraph Equipment. By LeRoy W. Stanton.	635
Water Power Transmission Plant at Elliott's Falls, Ontario. By Charles L. Fitch	642
Electricity and the Law in England and America. By W. Valentine Ball	645
The Shielded Balance. By G. A. Campbell	647
Important Electric Railway Tests at St. Louis	649
Cables for Electric Light and Power	650
The Economy of Reciprocating Engines at Light Loads as Compared with That of Steam Turbines. By J. A. Seymour	651
An Electrified English Steam Railroad	652
Annual Report of the Bell Telephone System	654
The Telephone Substation—II. By Arthur V. Abbott, C. E.	656
Production of Artificial Gas	657
An Electrical Engineer in Thibet	658
Cheap Current from Municipal Plants. By A. E. Winchester	660
Digest of Current Electrical Literature	660
New Portable Power-Factor Meter	664
Another Large Concern to Build Steam Turbines	665
Electromagnetic Track Brake	665
Hauling-in Heavy Cables	665
English Portable Testing Set	666
Oil Circuit Breakers	666
Mine Locomotive	666

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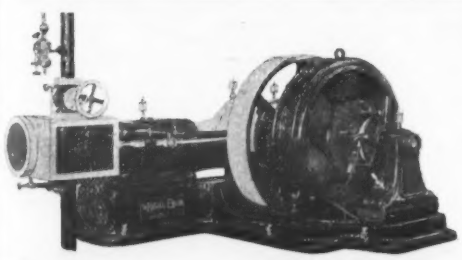

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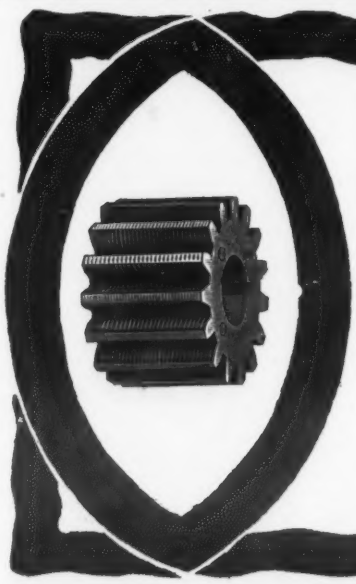

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(Continued on page 51.)

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1	160	Northern, M. P., compound	900
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1	210	Eddy, M. P.	1100
1	225	Card, M. P., comp.	690
1	260	Commercial, M. P., comp.	1100
1	300	Phoenix, M. P.	1100
1	300	Perrett, M. P., comp.	750
1	300	Ahlms-Edwards, M. P., comp.	825
2	300	Gen. Electric, M. P., comp.	1100
1	300	Western Elec., M. P., comp.	750
2	350	Edison, 20-K.W., comp., s-o.	1400
2	350	C. & C., M. P.	800
1	350	Card, M. P., enclosed	800
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1	20	Edison, self-oiler, comp.	1400
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1	50	C. & C., compound	800
1	50	Commercial, M. P., comp.	775
1	50	Maine, M. P., compound	600
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1	55	Eddy, M. P., comp.	750
1	60	Sprague, compound	500
1	60	Northern, M. P., comp.	800
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1	100	Edison, comp., self-oiler	650
1	100	Commercial, M. P., comp.	675
1	125	Eddy, M. P., comp.	700
2	150	National, M. P., comp.	350
1	200	Eddy, multipolar, compound	500
1	250	Western Electric, 6 pole, type L, 3 bearing, compound	450
1	300	Western Electric, M. P., brand new	480

DYNAMOS ❁ MONEY SAVERS ❁ ENGINES

DIRECT CONNECTED UNITS

1500-K.W 600 volts, Westinghouse generator and Allis Corliss c. p. engine.
4—375-K.W. Westinghouse, 550 volts, and Westinghouse compound engine.
1—300-K.W. Stanley 60 cy. 2 hp., 2400 v. and McIntosh & Seymour vertical c. p. engine.
1—300-K.W. G. E., Monocycle, 60 cy., 2300 v. and McIntosh & Seymour tandem engine.
2—150-K.W. Westinghouse single ph., 60 cy. and Harrisburg tandem engines.
2—125-K.W. General Electric, 250 v. (brand new) and any engine you desire.
80-K.W. Jenney, 6 pole, 125 v. and Russell 4-valve engine.
2—50-K.W. American Ball, 220 volts and American Ball engines.
1—50-K.W. Walker, 125 volts and Russell engine (new).
2—42-K.W. Westinghouse, 220 volts, and Alfrey engines.
30-K.W. Eddy, 125 volts, and Watertown engine.
25-K.W. Westinghouse, 125 volts, and Westinghouse engine.
7½-H.P. Northern, 125 v., and Hill vertical engine (new).
6-K.W. Northern, 125 volts, and Hill vertical engine (new).
4-K.W. Northern, 125 volts, and Hill vertical engine (new).
3-K.W. Northern, 125 volts, and Hill vertical engine (new).

BELTED UNITS

2—500-K.W. Westinghouse, 550 v., and Cooper Corliss engines.
2—300-K.W. G. E., 550 v., and Cooper Corliss engines.
1—150-K.W. Westinghouse, 550 volts, and 18½x18 A. L. Ide engine.
1—110 K.W. G. E., 6 pole, 550 volts, and 11x17x14 Harrisburg tandem engine.
1—250-K.W. Westinghouse, 2 ph., 60 cy., 2200 v., and 17x28x18 Harrisburg tandem engine.
1—100-K.W. G. E., 60 cy., 3 ph., 2200 v., and 11x17x14 Harrisburg tandem engines.

500 VOLT GENERATORS

2—500-K.W. Westinghouse, 4 pole.
2—300-K.W. General Electric, 4 pole.
1—150-K.W. Westinghouse, 4 pole.
1—110-K.W. General Electric, 6 pole.
2—100-K.W. General Electric, 4 pole.
2—100-K.W. Edison bipolar.
1—75-K.W. Westinghouse, 4 pole.
2—75-K.W. General Electric, 4 pole.
3—D-62-K.W. Thompson-Houston.
2—60-K.W. Edison bipolar.

220-250 VOLT GENERATORS

175-K.W. Eddy, 4 pole.
75-K.W. T. H., bipolar.
40-K.W. Crocker-Wheeler, 4 pole.

110-125 VOLT GENERATORS

2—66-K.W. General Electric, 4 pole.
2—60-K.W. Edison bipolar.
2—45-K.W. Edison bipolar.
1—30-K.W. General Electric, 4 pole.

ENGINES

16 and 30x48, Hamilton tandem.
3—11x17x14 Harrisburg tandem.
11x19x24 Buckeye tandem.
24x48 Wright of Newburgh.
16x38 Watts-Campbell Corliss.
2—13x12 Erie Ball automatic.
2—9½x10½ McIntosh & Seymour.
1—8½x8 Westinghouse.

BOILERS

540-H.P. Sterling 150 lbs. pressure.
4 Return tubulars, 72"x18', 120 lbs.

Boilers **THOMPSON SON & CO., 114 LIBERTY ST., N. Y.** Equipments

MODERN ELECTRICAL MACHINERY FOR SALE.

50-K.W. American Ball Dynamo & Engine.

110 VOLTS DIRECT CURRENT
Dynamos or Motors

30-K.W. Bullock, M. P.
15-K.W. Eddy, M. P.
10-K.W. Eddy, M. P.
5-K.W. C. & C.
3-K.W. C. & C.
2-K.W. Lundell.
1-K.W. C. & C.

500 VOLTS DIRECT CURRENT
Dynamos or Motors

15-H.P. General Elec., M. P.
7½-H.P. General Elec., M. P.
5-H.P. Sprague.
2-H.P. General Elec.

220 VOLTS DIRECT CURRENT
Dynamos or Motors

40-H.P. Sprague, M. P.
25-H.P. Crocker-Wheeler, M. P.
20-H.P. Card.
15-H.P. Sprague, M. P.
10-H.P. General Elec.
10-H.P. Holtzer Cabot.
7½-H.P. Card.
7½-H.P. Edison.
7½-H.P. C. & C.
5-H.P. Paragon, M. P.
5-H.P. Holtzer Cabot.
5-H.P. Crocker-Wheeler.
3-H.P. Diehl.
3-H.P. C. & C.
2-H.P. General Elec.
2-H.P. Diehl.
1½-H.P. C. & C.
1-H.P. Crocker-Wheeler.

ALTERNATING INDUCTION MOTORS

2 Phase, 60 Cycles, 220 Volts

30-H.P. Type F Westinghouse.
15-H.P. Type C Westinghouse.
10-H.P. Type C Westinghouse.
7½-H.P. Type C Westinghouse.
5-H.P. Type C Westinghouse.
2-H.P. General Elec.
1-H.P. Westinghouse.
½-H.P. General Elec., 220 or 110 v.
¼-H.P. General Elec.

2 Phase, 440 Volts, 60 Cycles

30-H.P. Westinghouse.
15-H.P. Westinghouse.
10-H.P. Westinghouse.
7½-H.P. Westinghouse.
5-H.P. Westinghouse.
3-H.P. Westinghouse.
1-H.P. Westinghouse.

3 Phase, 60 Cycles

5-H.P. Westinghouse, 220 volts.
2-H.P. Gen. Elec., 110 volts.
2-H.P. Westinghouse, 220 volts.
½-H.P. General Elec., 220 volts.
½-H.P. General Elec., 110 volts.

1 Phase, 60 Cycles

7-H.P. Wagner, latest type.
½-H.P. General Elec.
¼-H.P. General Elec.

1 Phase, 125 Cycles

3-H.P. Wagner, latest type.
1-H.P. General Elec.
½-H.P. Emerson.
1/18-H.P. Emerson.

Large stock of small motors, autostarters, starting boxes, rheostats, switchboards, voltmeters, ammeters, etc.

I BUY, RENT AND INSTALL.—GEORGE BENDER, 137 CENTRE STREET, NEW YORK.

ELECTRIC LOCOMOTIVES.

	Ton.	
1	10	Morgan-Gardner, type M, 250 v., direct current, double motor locomotive, 74-K.W., 42-inch gauge, speed 6 to 10 miles per hour
1	17	Morgan-Gardner, type N, 250 v., direct current, double motor locomotive, 115-K.W., 40-in. gauge, speed 8 miles per hour

500 TO 550 VOLT GENERATORS.

	K.W.		Speed.
1	60	Edison, comp., self-oiler, new armt. and commutator	800
1	62	T.-H., D 62, s-o., comp.	900
1	75	Akron, M. P., 6 pole	900
1	75	Bullock, multipolar	900
2	75	General Electric, M. P. 4, comp., new rewound	700
1	100	Siemens & Halske, 4 pole, with bar-wound armature, compound	600
2	100	Edison, compound	650
1	100	Gen. Elec., M. P. 4, comp.	650
1		General Electric slate panel switchboard for above, complete with ammeter, circuit breaker and resetting device, main line switch, rheostat switch, bus-bar connections, etc.	
2	120	Westinghouse, M. P., comp.	625
1	200	Thompson-Ryan, M. P., comp., three bearings	525
1	200	General Electric, M. P. 4, comp., s-o., 3 bearings, new commutator	400

ARC DYNAMOS.

	Lt.	C.P.		Speed.
1	35	2000	T.-H., L D 2 ball	820
1	45	1200	Brush, No. 7	1050
1	50	1200	T.-H., L D 12, new ball	820
2	50	2000	T.-H., M. D 2, s-o., ring	820
1	65	2000	Brush, No. 8	950
1	75	1200	T.-H., M D 12, s-o.,	820
1	75	1200	Wood	950
1	100	2000	Wood	600
1	125	1200	Brush, 6.6 amp.	700
2	125	2000	Brush, 9.6 amp.	500
1	125	1200	Excelsior	700

220 TO 250 VOLT MOTORS.

	H.P.	DIRECT CURRENT.	Speed.
1	1	General Electric, type I B	1025
1	1⅛	Commercial, self-oiler	1200
1	2	Lundell, newly rewound	1000
1	2½	Riker, s-o., with extra armt.	1460
1	3	C. & C.	1400
1	3	Bernard, M. P.	1525
1	3	Gibbs, M. P.	1400
1	3	Lundell, self-oiler	1500

BARGAINS IN (second-hand) ELECTRICAL MACHINERY

We do not offer old, worn out machines fit for the Junk pile, but the LATEST TYPES of the leading manufacturers.

GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing NET prices—all machines fully guaranteed.

2	1	General Electric, 110 volts	1800
3	3	Western Electric, M. P.	1000
3	3	Westinghouse, M. P.	1700
1	3	Storey, variable speed	300-1500
1	3½	Eddy, M. P.	400
1	4	Commercial, M. P.	450
2	5	Gibbs, M. P.	1400
3	5	Hobart, M. P.	1050
5	5	Western Electric, M. P.	950
1	5	Eddy, M. P.	300
3	5	Belknap, M. P.	230
2	5	Crocker-Wheeler special printing press motors, direct con.	318
1	6½	Jenny, M. P., back geared, speed of shaft	440
1	7½	Waddell-Entz, M. P.	900
1	7½	Edison	1350
1	7½	Towle, M. P.	1600
1	7½	Western Electric, M. P.	1150
2	7½	Western Electric, M. P.	950
1	7½	Milwaukee, M. P., series, crane type, grease cup	600
1	8	Holtzer-Cabot	1250
1	8	Crocker-Wheeler, series, crane type	900
1	8	Maine, M. P.	200
1	10	Standard, M. P.	670
1	10	C. & C., M. P., enclosed	1100
1	10	Keystone, M. P., enclosed	1175
1	10	Western Electric, M. P.	800
1	10	Story, M. P., enclosed	600
2	10	Westinghouse, M. P.	1250
3	10	Bernard, M. P.	130
1	12	C. & C., self-oiler	1100
1	15	Keystone, M. P.	1570
1	15	New England, M. P., 8 pole	650
1	15	Western Electric, M. P	625
1	18	Edison, 15 K.W.	1150
1	20	Eddy	1300
1	20	Kester	1250
2	25	Edison, self-oilers	1100
1	25	Western Electric	525
1	25	Keystone, M. P.	850

	H.P.		Speed.
1	25	Eddy, M. P.	725
1	25	Western Electric, M. P.	550
2	40	C. & C., self-oilers	650
1	40	Sprague-Lundell, M. P.	625
1	50	C. & C. multipolar	650
1	50	Eddy, M. P.	675
1	50	Am. Engine Co., M. P.	565
1	60	C. & C., self-oiler	600
1	60	Edison, self-oiler	750
1	60	Commercial, M. P.	600
1	60	C. & C., M. P.	560
1	60	Maine, M. P.	500
1	60	Western Electric, M. P.	425
1	60	General Electric, M. P.	800
1	65	Eddy, M. P.	650
1	70	Fuller, multipolar	600
1	75	Sprague, self-oiler	450
1	75	Northern, M. P.	700
1	85	Western Electric, self-oiler	500
1	100	C. & C., self-oiler	450
1	125	Edison, self-oiler	550
1	135	Commercial, M. P.	675
1	150	Eddy, M. P.	600
2	200	National, M. P.	300

500 TO 550 VOLT MOTORS.

	H.P.		Speed.
1	1	General Electric, C. A.	1200
1	1½	Belknap, self-oiler	1700
2	1½	Northern, series	1400
2	1½	Crocker-Wheeler	1550
1	2	Maine, M. P.	1100
1	2½	Bain, self-oiler	2100
1	2½	New England	1500
1	3	C. & C., self-oiler	1600
1	3	General Electric, type C E	1800
1	3	Maine, M. P.	1100
1	3	Jenney, M. P., back geared, speed of shaft	240
1	3½	Roth	1700
1	3½	Roth, M. P.	950
1	3½	Westinghouse, M. P.	1050

	H.P.		Speed.
1	4	Edison, 3 K.W.	1700
4	4	Maine, multipolar	550
1	4	Bernard, M. P.	550
1	5	Hobart, self-oiler	1600
1	5	Fort Wayne	1400
2	5	Triumph, M. P.	1350
3	5	Crocker-Wheeler	950
1	6	C. & C., enclosed	1030
2	6	T.-H., D 5, self-oilers	1800
2	7½	Thomson-Houston, D 7½	1600
1	7½	Roth, self-oiler	1400
1	7½	Card, multipolar	775
1	7½	Jenney, M. P.	1500
1	7½	C. & C., M. P., compound	1160
3	7½	Crocker-Wheeler	1500
1	7½	Eddy, M. P.	875
1	10	Phoenix, M. P.	950
1	10	Crocker-Wheeler	1275
1	10	Northern, M. P.	1350
1	10	Triumph, M. P.	1100
2	10	General Electric, M. P.	1400
1	10	Perrett, M. P., compound	600
1	10	Eddy, M. P.	650
3	10	Belknap, M. P.	500
1	12	Am. Engine Co., M. P.	1365
1	15	Eddy, self-oiler	1725
1	15	C. & C., self-oiler	975
1	15	Edison	1375
1	15	Perrett, M. P.	1100
1	15	Maine, M. P.	450
1	20	Eddy, self-oiler	1500
1	20	Perrett, M. P.	700
1	20	Holtzer-Cabot, M.P., enclosed	1150

ALTERNATING CURRENT MOTORS.

SINGLE PHASE. 125-133 CYCLES.

	H.P.		Speed.
10	½	Stanley, 100-110 volts, new	2400
1	½	Holtzer-Cabot, 104 volts	2500
1	½	Emerson, 104 volts	2000
1	½	Wagner, 104 volts, aut.	2000
1	1	Fort Wayne, 104 volts	2500
1	1	Wagner, 208 volts, aut.	2000
1	1½	Wagner, 208 volts, aut.	2000
1	3½	Wagner, 110 volts, automatic	1875

THREE PHASE. 125-133 CYCLES.
For Monocyclic System.

	H.P.		Speed.
1	3	General Electric, 110 volts	1875

SINGLE PHASE. 60 CYCLES.

	H.P.		Speed.
2	½	Phillips, 104 volts	1800
1	½	General Electric, type I S, 110 v., with type K. S. condenser-compensator, new	1800
1	¾	Gen. Elec., type I. S., form L	1800
1	1	Phillips, 208 volts	1600
1	1	Phillips, 104 volts	1600
1	2	Wagner, 500 volts, aut.	1800
1	2	Wagner, 104 volts	1800
1	15	Wagner, 104 volts, aut.	1200
2	30	Wagner, 104 volts, automatic	1200

For Sale:—Four 22' and 42' x 48'

Hamilton Tandem Compound Condensing Corliss Engines

With Independent Condenser for Each. Wheels: 24 ft. x 50 ins. 60,000 lbs. Capacity: 750 to 1,000 H. P. Each. Located in New York City.

900-H.P. 34x60 International Power Corliss.
450-H.P. 16 and 30x42 Allis Compound Corliss.
450-H.P. 24x48 Brown Corliss.
400-H.P. 23x60 Geo. H. Corliss.
300-H.P. 20x48 Harris Corliss.
275-H.P. 20x42 Hamilton Corliss Engine.
225-H.P. 18x42 Hamilton Corliss.
200-H.P. 18x36 Bates Corliss.
200-H.P. 12 and 22x42 Atlas Compound Corliss.
175-H.P. 16x42 Allis Corliss.
150-H.P. 15x38 Brown Corliss.
125-H.P. 14x36 Putnam Corliss.
100-H.P. 12x36 Harris Corliss.
85-H.P. 12x30 Lane and Bodley Corliss.
650-H.P. 28½x52 Buckeye Automatic.
450-H.P. 24x48 Buckeye Automatic.
400-H.P. 16½ and 28½x27 Buckeye Compound Automatic.
250-H.P. 16 and 27x16 Westinghouse Compound.
100-H.P. 13x12 Ideal S. O. Automatic.
90-H.P. 12x20 Atlas Side Crank Automatic.
90-H.P. 12x16 Erie Center Crank Aut.
40-H.P. 9x13 Frost Side Crank Automatic.

BOILERS

1—350-H.P. Babcock and Wilcox Boiler, 150 lbs.
1—280-H.P. Babcock and Wilcox Boiler, 150 lbs.
2—265-H.P. Babcock and Wilcox Boilers, 150 lbs.
3—265-H.P. Babcock and Wilcox Boilers, 135 lbs.
1—175-H.P. Babcock and Wilcox Boiler, 125 lbs.
1—172-H.P. Babcock and Wilcox Boiler, 130 lbs.
1—250-H.P. Cahall Vertical Boiler, 160 lbs.
14—72x22 Tubular Boilers, 115 lbs.
7—72x18 Tubular Boilers, 120 lbs.
7—72x18 Tubular Boilers, 100 lbs.
3—72x16 Tubular Boilers, 100 lbs.
8—66x18 Tubular Boilers, 100 lbs.
3—66x16 Tubular Boilers, 100 lbs.
1—60x18 Tubular Boiler, 100 lbs.
4—60x16 Tubular Boilers, 100 lbs.
2—60x14 Tubular Boilers, 120 lbs.
Cookson Heaters, 50, 75, 100, 150 and 200 H.P.

WHITEHEAD MACHINERY CO., Davenport, Iowa.
Eastern Office, 517 Park Building, Pittsburgh, Pa.

FOR SALE.

DIRECT CONNECTED.

30-K.W. Eddy dynamo to Watertown engine, 110 volts.
10-K.W. Westinghouse dynamo to Armington & Sims engine, 110 volts.
10-K.W. Westinghouse dynamo to Westinghouse engine, 110 volts.
80-Amp. Edison dynamo to Brotherhood engine, 80 volts.
20-H.P. Elektron 220 volt motor to Morse Williams freight elevator.

BELTED.

60-amp. Crocker-Wheeler to Herresoff engine, 110 volts.
2000 volt Electro Dynamic arc dynamo, 10 amperes.
500-Lt. Edison dynamo, 110 volts.
60-amp. Westinghouse dynamo to Westinghouse engine, 110 volts.
35-amp. Sprague dynamo to Hornby Ackroyd oil engine.
600-Lt. Weston dynamo, 110 volts.
500-Lt. Edison Dynamo, 110 volts, D.C. to Brotherhood engine.
400-Lt. Excelsior dynamo, 110 volts.
45-H.P. C. & C. motor, 230 volts.
30-H.P. C. & C. motor, 230 volts.
15-H.P. Thomson-Houston motor, 500 volts, with spare armature.
15 General Electric, 2-H.P., 220 volt motors.
12 Siemens & Halske 5-H.P., 220 volt motors, 220 volts, 1550 R.P.M.
2 search lights.

These motors are dust proof and series wound.

Large stock of smaller dynamos and motors.

Repairing of electrical machinery in all its branches.

JORDAN BROS., 74 Beekman St., N. Y.

A WELL ORGANIZED NEW YORK ENGINEERING COMPANY

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controlling very valuable selling agencies—already on paying basis—will sell $10,000 of its seven per cent. participating preferred stock, at par, to party thoroughly competent to take charge of Chicago office. Address

No. 1405, care Electrical World and Engineer, New York

GENERATORS.

1—180-K.W. General Electric, 60 cycle, single phase.
2—120-K.W. General Electric, 60 cycle, single phase.
1—120-K.W. Westinghouse, 60 cycle, two phase.
360-K.W., 150-K.W., 120-K.W. and 75-K.W., sizes in 125 cycle alternators.
1—100-K.W. General Electric, 8 pole, 125 volt generator, direct connected to 15½ x 15 engine.
175-K.W., 150-K.W., 100-K.W., 75-K.W. and 30-K.W., sizes in direct current generators, 140 and 250 volts.
1—200-K.W. Westinghouse Railway Generator.

ENGINES.

1—Brand New 18 x 16 American Ball Automatic Engine, ready to ship.
1—16 x 30 x 48 Cooper Cross-compound, Condensing Corliss.
1—22 x 48 Allis Corliss, with heavy sectional band wheel.
1—18¾ x 30 Buckeye, Class 'A."

Write for List No. 42 of Dynamos, Engines and Boilers.

STATION EQUIPMENT COMPANY, 204 DEARBORN ST., CHICAGO.

WRITE FOR OUR CATALOGUE OF ELECTRICAL BOOKS

DIELECTRIC VARNISH

OIL PROOF
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(5) DIELECTRIC MNFG. CO., SAINT LOUIS

Dynamo and Motor Repairing

Armature Winding, Armature Coils. Commutators, Gears and Pinions.

Our Specialty **Railway Field Coils** of Every Type

The ELLIOTT BROS. ELECTRIC CO.
Cleveland, O.

I Can Sell Your Electrical or Other Business

(with or without real estate) no matter where it is or what it is worth. Send description, state price, and learn how. I have a special department for buying and selling electric light and gas plants. If you want to buy, tell me your requirements. W. M. OSTRANDER, 196 North American Building, Philadelphia.

A POSITION IS OPEN

Do you know where it is? We do. We have openings for high-grade men of all kinds — Executive, Technical, Clerical — paying from $1,000 to $10,000 a year. High grade exclusively. Write for plan and booklet. (4)

HAPGOODS (Inc.)
Suite 511, 309 Broadway, New York

FOR SALE

A new up to date electric light plant; can show 12 per cent. to 14 per cent. on investment; exclusive city franchise; have city lighting. Address No. 1369, care Electrical World and Engineer, New York.

FOR SALE OR TRADE.

35-H.P. 230-volt Western Electric motor, $225.00
2-H.P. 500-volt T. H. motor, $45.00.
75 light, 110-volt Westinghouse dynamo, $70.00.
125 light, M. P., Ruprecht, 110 volts, $90.00.
3-H.P. Mather, 500 volts, $40.00.

The Standard Machinery & Equipment Co.
410 Electric Building, Cleveland, Ohio.

If you want to do business with any man in the electrical field in any part of the world the right medium to advertise in is Electrical World and Engineer.

WANTED

One copy each of ELECTRICAL WORLD AND ENGINEER, dated July 29, 1899; July 12, 1902; July 11, 1903.

Copies must be clean and well preserved; will pay face value. Address No. 1372, care Electrical World and Engineer, New York.

HOW MANY READERS

OF ELECTRICAL WORLD AND ENGINEER HAVE A FULL KNOWLEDGE OF EVERYTHING YOU MAKE?

They may never have known, or they may have known years ago.

They may still have a partial knowledge; but unless you

ADVERTISE PERSISTENTLY

it does not take very long to be forgotten.

PROPOSALS

In virtue of a resolution of the Municipal Council of San Luis Potosi, approved by the superior Government of the State, contractors for electric lighting are invited to present their propositions for the public illumination of this city, with the understanding that the contract that may be made shall be based upon the following clauses:

I. The contractor by himself, or through the company or companies he may organize, shall establish in this city an Electrical Plant according to the latest and most adequate system in the opinion of such experts as the commission of this department shall duly appoint.

II. He shall be bound to establish by the last day of the present year the service of the illumination with a number of arc lights which shall not be less than one hundred and fifty, distributed according to the plan which shall be given him by the commission of illumination, who shall have the power to modify this distribution whenever it should be necessary within a reasonable term determined by same.

III. These lights shall illuminate daily from the setting of the sun until its rising on the following day.

IV. The contract shall be made for no less than fifteen years, and shall not be rescindable, except in the cases provided for by the law or by mutual consent between the contracting parties.

V. The price per light or for all the lights contracted for, shall be paid by the Municipal Council at the end of each month.

VI. The enterprise that shall have the preference shall make use of the streets, squares and other public places for their conductors, etc., in accordance with the respective commissions taking in consideration the concessions granted previously. Their plant shall be established outside of the perimeter marked out by the respective commissions.

VII. Said enterprise, within a month after the acceptance of their propositions, shall guarantee the fulfilment of their obligations by making a deposit of five thousand pesos in favor and to the satisfaction of the Municipal Council.

VIII. In said propositions mention must be made of the systems adopted for the lighting and installations, the power of each light and apparatus to show same, the price asked for, and, in short, all the details of the business.

IX. Upon making the agreement, details shall be also given as to the terms to be adopted, the capital to be paid out, the streets and other public places that may be used and penalties for the contracting parties, etc., etc.

X. This convocation shall be closed on the fifteenth of May of the present year and shall be published in the Republic as well as in the United States and in Europe.

San Luis Potosi, Mexico, Feb., 1904.

(Signed) Enrique Milán, Sec'y.

For Sale. DIRECT CONNECTED APPARATUS

Direct Connected Direct Current
125 TO 250 VOLTS

1—425-K.W. unit consisting of two 210-K.W. 140-volt MP engine type General Electric generators, 120 R.P.M., direct connected to one 24 x36 Wright Corliss engine, for use on 125 or 250-volt circuit.

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(*Continued from page 48.*)

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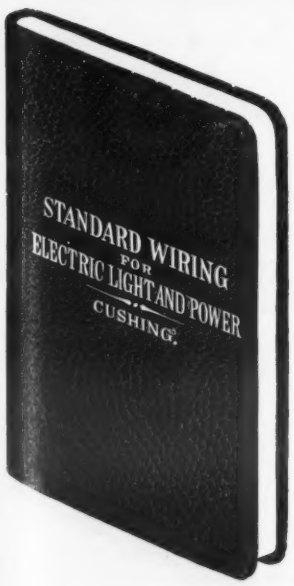

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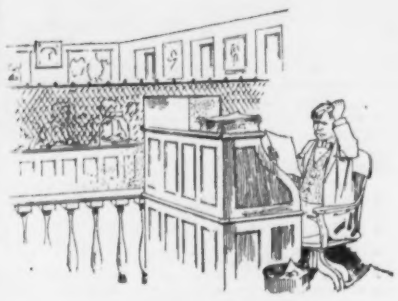

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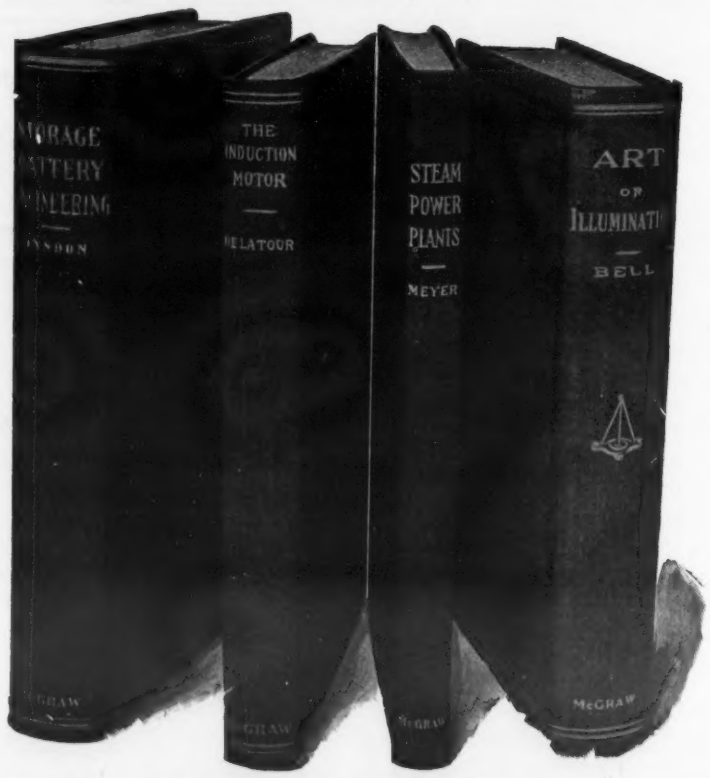

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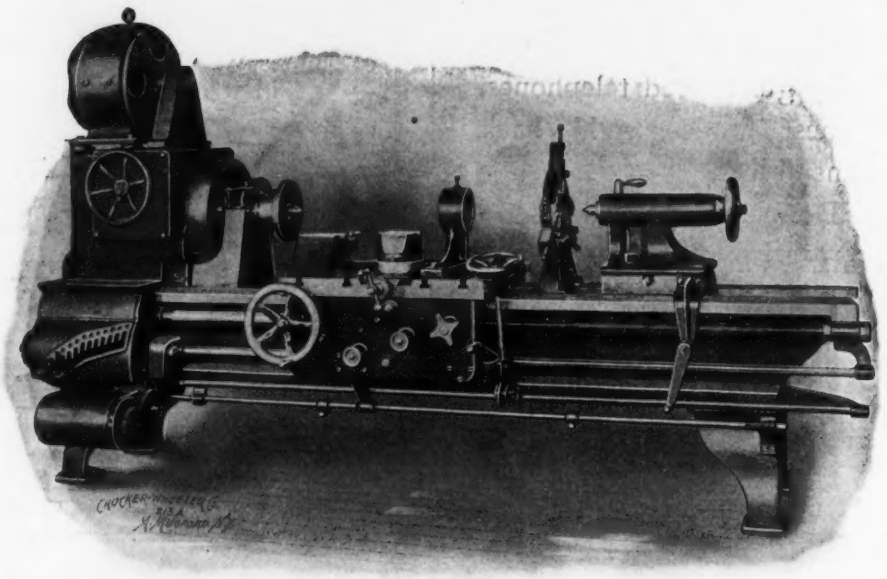

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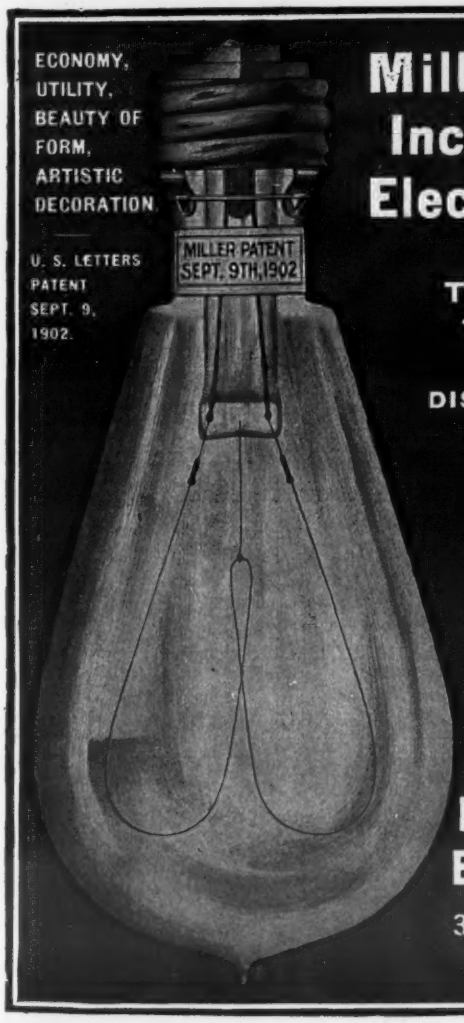

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ALPHABETICAL INDEX TO ADVERTISERS.

Adams-Bagnall Elec. Co. ....
Aitchison Perforated Metal Co., R. 72
Akron Elec., Mfg. Co. 68
Alberger Condenser Co. 77
Allen Co., L. B. 46
Allis-Chalmers Co. 78
American Battery Co. 55
American Bell Telephone Co. 62
American Bridge Co. 59
American Circular Loom Co. 1
American Conduit Co. 20
American Diesel Engine Co. 76
American District Steam Co. 76
American Electric Fuse Co. 23
American Electric Telephone Co. 62
American Electrical Heater Co. 21
American Electrical Mfg. Co. 42
American Electrical Works 2
American Endoscopic Co. ....
American Engine Co. 81
American Insulated Wire & Cable Co. 17
American Insulating Machinery Co. 73
American Platinum Works 2
American Reflector & Lighting Co. 22
American School of Correspondence. ....
American Stone Conduit Co. 21
American Transformer Co. 1
American Vitrified Conduit Co. 20
American Vulcanized Fibre Co. ....
Anderson Mfg. Co., A. & J. M. 9
Anyun Lamp & Elec. Co. 21
Archer, Geo. F. 60
Arnold Elec. Power Station Co. 60
Ashley & Stern 60
Atlantic Insulated Wire & Cable Co. 55
Atwater Kent Mfg. Co. 63
Audel & Co., Theo. 56
Automatic Elec. Co. 63

Babcock & Wilcox Co. 75
Baillard, E. V. 84
Baker & Co. 3
Baker & Co., W. E. 60
Ball & Wood Co. 79
Ball Engine Co. 81
Banner Elec. Co. ....
Barnes Co., The Wallace 31
Barnes Co., W. F. St. John 73
Barnett Co., G. & H. 76
Barstow, W. S. 60
Bates & Bros., D. L. ....
Bates Machine Co. 21
Bay State Stamping Co. 81
Bayley & Sons Co., Wm. 77
Becken, A. C. 84
Becker Engraving Co., A. 1
Beebe & Bennett 60
Bellevue Porcelain Works 38
Bender, Geo. 57
Benjamin Elec. Mfg. Co. 29
Biddle, James G. 3
Bishop Gutta Percha Co. 84
Bissell Co., F. 24
Bogue, Chas. J. 55
Bossert Electric Const. Co. 23
Brady, T. H. 10
Bridgeport Brass Co. 1
Brilliant Elec. Co. 17
Bristol Co. 1
Brown Electrical Const. Co. 60
Bryan-Marsh Co. ....
Buckeye Electric Co. ....
Buckeye Engine Co. 79
Bullock Electric Mfg. Co. 69
Burch, Edward P. 60
Burt Mfg. Co. 3
Byllesby & Co., H. M. 60
Byrnes & Townsend. ....

C. & C. Electric Co. 70
C., C., C. & St. L. Ry. ....
Calculagraph Co. 62
Caldwell, Edward 59
Calman & Co., Emil 2
Camp Co., H. B. 20
Carlisle & Finch Co. 77
Carman & Co., Chas. Whitney 60
Carpenter Tap & Die Co., J. M. 73
Cary Spring Works 23
Case Mfg. Co. 18
Central Tel. & Elec. Co. ....
Century Electric Co. 13
Chapman, Chas. A. 60
Chase-Shawmut Co. ....
Chicago & Alton Railway. ....
Chicago & Northwestern Railway. ....
Chicago Edison Co. 61
Chicago Fuse Wire & Mfg. Co. 84
Chicago Insulated Wire Co. 19
Chicago, Milwaukee & St. P. Ry. ....
Christensen, N. A. 75
Cincinnati Tool Co. 10
Clark Automatic Telephone S. B. Co. 60
Clark Wireless Telegraph & Telephone Co., Thos. E. 63
Coho & Co., H. B. 60
Coleman, W. E. ....
Collins, A. Frederick. ....
Colonial Electric Co. 32
Columbia Inc. Lamp Co. 31
Columbus Storage Battery Co. 14
Commercial Elec. Co. 70
Compressed Fibre Co. 37
Conn. Tel. & Elec. Co. 63
Conord & Sons, Eugene 17
Conover Mfg. Co. ....
Consolidated Railway, Elec. Lighting & Equipment Co. 71
Cook, F. B. 62
Cope, T. J. 21
Copenhagen Auto Fire Alarm Co. 16
Corson, Wm. R. C. 60
Couch Co., S. H. 63
Crane Co. .... 76 & 77
Crawfordsville Electric Co. 45
Crescent Co. 22
Crescent Insulated Wire & Cable Co. 84
Crocker-Wheeler Co. 66
Crompton & Co., Ltd. ....
Crosby Steam Gage & Valve Co. 3
Croselmire & Ackor Co. 2
Crouse-Hinds Co. 24
Crowe Metal Mfg. Co. 68
Cutler-Hammer Mfg. Co. 25
Cutter Elec. & Mfg. Co. 46

D. & W. Fuse Co. 9
Dale Company 29
Dayton Fan & Motor Co. ....
Dearborn Drug & Chemical Works. 75
Delaware Hard Fibre Co. 84
Devine, J. P. 30
Dialt Motor Co. 65
Diamond Meter Co. 4
Diehl Mfg. Co. 13
Dielectric Mfg. Co. 58
Directory of Engineers. .... 60 & 61
Dixon Crucible Co., Jos. 75
Doble, Robert McF. 60
Dongan Instrument Co. 5
Doubleday-Hill Electric Co. 40
Downward Light Elec. Co. ....
Driver-Harris Wire Co. 7
Dunbar Bros. ....
Duncan Electric Mfg. Co. 6
Dyer & Dyer. 55

Eastern Arm & Pin Co. 10
Eastern Carbon Works. 14
Eccleston Lumber Co. 10
Eck Dynamo & Motor Works. 68
Economical Electric Lamp Co. 84
Edison Dec. & Min. Lamp Dept. 46
Edison Mfg. Co. 14
Edwards & Co. 37
Eldredge Elec. Mfg. Co. 3
Electric Appliance Co. 46
Electric Contract Co. 44
Electric Controller & Supply Co. 18
Electric Launch Co. ....
Electric Machinery Co. 68
Electric Motor & Equipment Co. 30
Electric Storage Battery Co. 9
Electrical Engineers Inst. of Cor. Inst. 2
Electrical Equipment & Supply Co. ....
Electric Specialty Co. 17
Electrical World & Engineer. 34
Electro-Dynamic Co. 4
Elliott Bros. Electric Co. 58
Elwell-Parker Electric Co. 71
Emerson Elec. Mfg. Co. 13
Empire China Works. 55
Empire Electrical Instrument Co. 1
Engineers, Directory of. .... 60 & 61
Engineering Record 9

Federal Electric Co. 68
Federal Electric Co. 22
Fibre Conduit Co. 21
Foote, Pierson & Co. 7
Ford, Bacon & Davis. 60
Foster, Horatio A. 60
Fort Wayne Electric Works. 28
Franklin Electric Mfg. Co. 35
Frick Co. 78
Frink, I. P. 37
Frorup, L. E. 30
Fuller Co. 80

Garton-Daniels Co. 38
General Electric Co. .... 26 & 27
General Engineering Co. 60
General Inc. Arc Lt. Co. 12
Germania Elec. Lamp Co. 31
Gest, G. M. 21
Gherky, Wm. D. 21
Gilmore Electric Co. 65
Globe Electric Controller Co. 23
Goepel & Niles. 55
Goudey-McLean Co. ....
Gould Storage Battery Co. 3
Green & Co., W. 22
Green Fuel Economizer Co. 75
Gregory Electric Co. .... 56 & 57

H. O. S. Eng'g Co. 17
Haas Elec. & Mfg. Co., R. 37
Haller Machine Co. ....
Hamerschlag Cons. Co. 68
Hanchett, Geo. T. 60
Hapgoods (Inc.) 59
Hardinge Bros. ....
Harrisburg Foundry & Mach. Wks. 78
Hart Mfg. Co. 9
Hartford Faience Co. 10
Hartford Time Switch Co. 38
Hatch Accumulator Co. 14
Hazard Mfg. Co. ....
Heck, Louis 58
Hemingray Glass Co. 23
Hertner Electric Co. 61
Hill Brass Co., N. N. 38
Hill Elec. Co., W. S. 24
Hobart Elec. Mfg. Co. ....
Hoffman, George W. 56
Holophane Glass Co. 2
Holtzer-Cabot Elec. Co. ....
Horry, Wm. Smith 60
Horton-Massnick Co. 46
Humphrey, Henry H. ....
Hunt Co., C. W. 72
Hunter Fan & Motor Co. 11
Hunter Machine Co. ....
Hutton Engineering Co. 60

Ide & Sons, A. L. 80
Ideal Elec. & Mfg. Co. ....
Illuminating Appliance Co. ....
Imperial Porcelain Works. 38
Incandescent Elec. Lt. Manip. Co. ....
India Rubber & G. P. Ins. Co. 16
Indiana Rubber & Ins. Wire Co. 1
Internatl. Brass & Elec. Co. 19
Internatl. Correspondence Schools. 29
Internatl. Telph. Mfg. Co. 63
Iron City Engineering Co. 60

J-E-M Shade Holder Co. 84
Jackson, Dugald C. 60
Jackson, Wm. B. 60
Jaeger Miniature Lamp Mfg. Co. 84
Jeffrey Mfg. Co. 73
Jenkins Bros. 1
Jenney Elec. Mfg. Co. 68
Johns-Manville Co., H. W. 7
Johnson & Morton 24
Johnston, Thomas J. 55
Jordan Bros. 58

Kartavert Mfg. Co. ....
Kellogg & Co., E. H. 84
Kellogg Switchboard & Supply Co. .... 10 & 64
Kelly Engineering Co., John F. 60
Keystone Electric Co. 69
Keystone Elec. Inst. Co. 46
Kilbourne & Clark Co. 1
Kinsman Elec. & Ry. Supply Co. ....
Klein & Sons, Mathias 10
Kliegl Bros. 21
Klipstein & Co., A. ....
Knapp Elec. Novelty Co. 13
Kohler Bros. 60
Kruesi, P. J. 55

Lakon Co. 41
Lamp Testing Bureau. 46
Lang Electric Co., J. ....
Lansingh, Van Rensselaer. 61
La Roche Co., F. A. ....
Leclanche Battery Co. 3
Leeds & Northrup Co. 5
Leffel & Co., James. 45
Leslie & Co., A. C. ....
Le Valley Vitæ Carbon Brush Co. ....
Linch & Stover. 76
Lincoln Elec. Co. 70
Lindsley Bros. Co. 10
Lippincott Glass Co. 32
Link-Belt Engineering Co. 72
Locke Insulator Mfg. Co. 37
Lombard Governor Co. ....
Lowell Model Co. ....
Lundin Elec. & Machine Co. 24
Lunkenheimer Co. 75

McCullough-Dalzell Crucible Co. 22
McGill University 45
McGowan & Co., John H. 73
McIntosh, Seymour & Co. 80
McLennan & Co., K. 56
McLeod, Ward & Co. 22
Machado & Roller 37
Mailloux, C. O. 61
Manhattan Electrical Supply Co. 23
Manross, F. N. 23
Marinette Gas Engine Co. 77
Maris Bros. 73
Marshall, William 84
Masson, R. S. 61
Maxfield-Francke Co. 79
Mead Mfg. Co., J. A. 72
Mechanical Appliance Co. 68
Meyrowitz, E. B. 37
Mica Insulator Co. 37
Michigan College of Mines. 45
Milwaukee Electric Co. 70
Minchin, C. H. ....
Missouri American Elec. Co. 35
Moloney Elec. Co. 45
Monson Burmah Slate Co. 45
Montauk Fire Detecting Wire Co. 16
Moore, A. F. 1
Morse Twist Drill & Mach. Co. ....
Munder Electric Co. ....
Munroe, Hall & Hopkins. 61
Munsell & Co., Eugene 37
Muralt & Co. 61
Murdoch, H. D. ....
Mustard, John ....

National-Acme Mfg. Co. ....
National Battery Co. 15
National Conduit & Cable Co. ....
National Electric Co. 67
National Electric Signalling Co. 65
National India Rubber Co. 1
National Switchboard Co. 36
National Wire Corporation. 17
National X-Ray Reflector Co. ....
Nernst Lamp Co. 33
New England Butt Co. 19
New England Motor Co. 68
New Process Rawhide Co. 55
New York & Ohio Co. 1
New York Central R. R. 19

Continued on Page 38.

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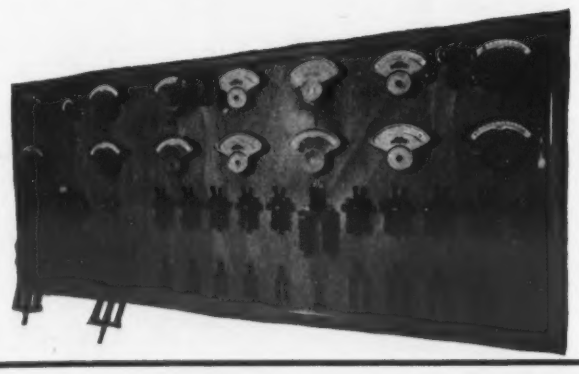

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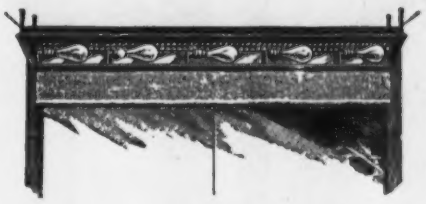

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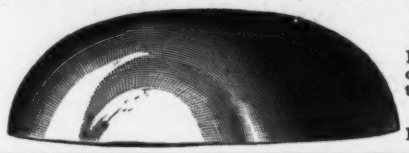

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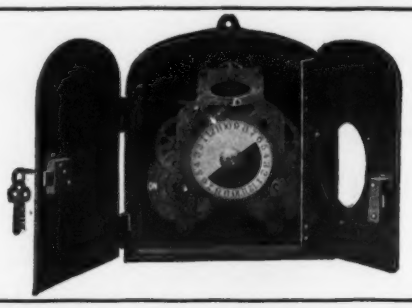

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ALPHABETICAL INDEX TO ADVERTISERS.—*Continued from Page 36.*

New York Insulated Wire Co..... 1
New York Safety Steam Power Co... 75
New York Telephone Co..... 63
Niles-Bement-Pond Co.....
North Electric Mfg. Co..... 61
Northern Electric Mfg. Co..... 71
Northern Eng'g Works..... 72
Northwestern Electric Co.....

Okonite Co., Ltd..... 1
Osburn Flexible Conduit Co..... 1
Ostrander, W. M.....
Ostrander & Co., W. R..... 3
Otto Gas Engine Works..... 77

Paiste Co., H. T..... 46
Palmer, W. K..... 61
Parsell & Weed..... 84
Pass & Seymour, Inc.....
Patterson, H. C..... 61
Pawling & Harnischfeger..... 72
Peerless Rubber Mfg. Co..... 75
Peirce, C. L., Jr.....
Pelton Water Wheel Co..... 45
Pepper & Register..... 61
Perkins Electric Switch Mfg. Co..... 26
Peterson & Co., John L.....
Phelan, D. W..... 10
Phœnix Glass Co..... 1
Phosphor-Bronze Smelting Co..... 77
Pierce, Richardson & Neiler..... 61
Pignolet, Louis M..... 5
Porter Cedar Co..... 10
Power & Mining Mach. Co..... 76
Power Installation Co..... 61
Pratt, Chas. R..... 61
Pratt & Atkins..... 61
Pratt & Whitney Co.....
Prometheus Electric Co..... 17
Proposals .....58 & 59
Providence Engineering Works..... 81
Pulsometer Eng'g Co., Ltd.....

Queen & Co..... 4
Quimby, Wm. E., Inc..... 77

Reckenzaum, Fred'k .....

Reeves Engine Co..... 79
Reidy, J. J..... 10
Reisinger, Hugo 31
Renim Specialty Co.....
Reynolds Electric Flasher Mfg. Co.... 56
Richardson Scale Co..... 55
Ridgway Dyn. & Eng. Co..... 80
Rittenhouse-Miller Co..... 21
Robbins & Myers Co.....11 & 69
Robins Conveying Belt Co..... 72
Rochester Mach. Tool Works..... 78
Rockwood Mfg. Co..... 74
Roebling's Sons Co., John A..... 16
Roessler & Hasslacher Chemical Co....
Rosenbaum, W. A..... 55
Rosenberg Co., A.....
Rossiter, MacGovern & Co..... 59
Rotary Engine Co..... 81
Roth Bros. & Co.....
Ruel, A. J..... 58
Rushmore Dynamo Works..... 1
Russell, Tomlinson Electric Co..... 65
Ryle & Co., William..... 3

Safety Insulated Wire & Cable Co.... 17
Samson Cordage Works..... 46
Sanderson & Porter..... 61
Sangamo Electric Co.....
Sargent & Lundy..... 61
Sawyer-Man Electric Co..... 33
Schoonmaker, A. O..... 2
Schoonmaker Co., A. G.....
Schott, W. H..... 61
Schureman & Co., J. L..... 18
Scranton Button Co..... 17
Sears, Henry D..... 38
Sebastian Lathe Co..... 73
Seneca Falls Mfg. Co..... 73
Shain, Chas. D..... 2
Sheaff & Jaasted..... 61
Shelby Elec. Co..... 28
Shepherd Engineering Co..... 81
Shultz Belting Co..... 1
Siemon Hard Rubber Corporation.... 64
Signaloid Chemical Works..... 21
Sills-Eddy Mica Co..... 29
Simplex Electric Heating Co.....
Simplex Electrical Co..... 1
Skinner Engine Co..... 79
Smith Co., S. Morgan..... 45
Smith, Hemenway & Co., Corp..... 3
Smith Storage Battery Co..... 15
Southwark Foundry & Mach. Co..... 78
Splitdorf, C. F..... 2
Sprague Elec. Co..... 12
Standard Elec'l Mfg. Co..... 22
Standard Paint Co.....
Standard Underground Cable Co.....
Standard Vitrified Conduit Co..... 20
Stanley Elec. Mfg. Co..... 41
Stanley Instrument Co..... 7
Stanton, Le Roy W..... 61
Station Equipment Co..... 58
Sterling & Son, W. C..... 10
Sterling Elec. Co..... 64
Sterling Elec'l Mfg. Co..... 30
Sterling Varnish Co..... 46
Steward Mfg. Co., D. M..... 55
Storage Battery Supply Co..... 14
Stow Mfg. Co..... 73
Straley, Hasbrouck & Schloeder..... 58
Strock, S. C..... 10
Stromberg-Carlson Telph. Mfg. Co.... 64
Stuart Howland Co..... 2
Sturgess Governor Eng'g Co.....
Sturtevant Co., B. F..... 71
Sunbeam Incandescent Lamp Co.....
Sundh Electric Co.....
Sunlight Lava Mfg. Co..... 55
Sunlight Reflector Co..... 46

Talmont Electric Eng'g Co.....
Thomas & Sons, Co., R..... 39
Thompson-Bonney Co..... 59
Thompson, Son & Co..... 57
Tipless Lamp Co.....
Tod Co., The William..... 76
Townsend & Decker..... 55
Trenton Porcelain Co..... 19
Triumph Elec. Co..... 68
Trumbull Elec. Mfg. Co.....

United Button Co..... 17
United Electric Heating Co.....
U. S. Battery Co..... 84
United Telpherage Co..... 71
Utica Drop Forge & Tool Co..... 3

Va. Locust Pin Co..... 10
Valentine Clark Co..... 10
Vance, D. T.....
Van Nostrand Co.....
Van Winkle, Edward..... 61
Varley Duplex Magnet Co..... 64
Viaduct Co..... 63
Vilter Mfg. Co.....
Vulcanized Fibre Co..... 4

Wagner, Herbert A..... 61
Wagner Elec. Mfg. Co..... 67
Want and For Sale Ads.....
Ward Leonard Elec Co.....17-19-21 & 23
Warner, W. F.....
Warner Instrument Co..... 6
Warren Electric & Specialty Co..... 35
Warren Elec. Mfg. Co..... 65
Waterbury & Co..... 84
Watertown Engine Co..... 78
Watson-Stillman Co..... 73
Webster Chemical Co..... 22
Weiss, W. F..... 1
Western Display Co..... 22
Western Electric Co..... 5
Westinghouse Elec. Mfg. Co..... 83
Westinghouse Machine Co..... 82
Weston Elec. Inst. Co..... 6
Wetherill & Co., Robt..... 78
White & Co., J. G..... 61
Whitehead Machinery Co.....
Whitted, Thos. B..... 61
Whitney Elec. Inst. Co..... 37
Willard Storage Battery Co..... 14
Willyoung & Gibson Co..... 5
Wirt Electric Co..... 39
Wood & Co., R. D..... 77
Woodward Governor Co.....
Worcester Co., C. H..... 10

Yale & Towne Mfg. Co..... 72
Yost Elec. Mfg. Co.....

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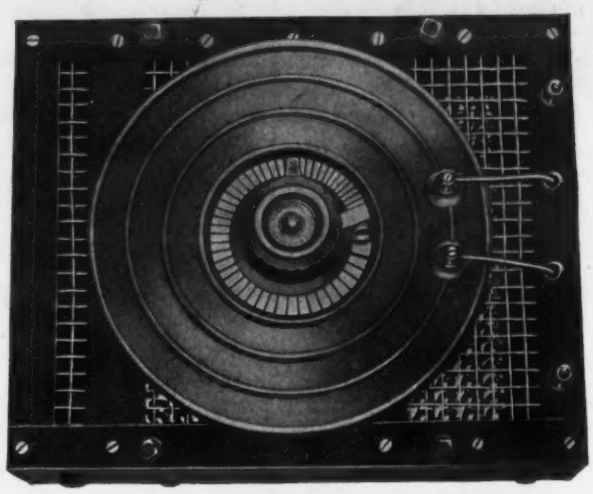
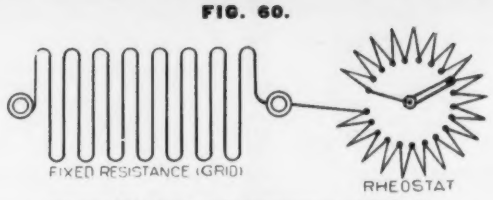


FIG. 60.



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CLASSIFIED INDEX.

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Shultz Belting Co.

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Johns-Manville Co., H. W.
Simplex Electrical Co.

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Consolidated Railway Electric Lighting & Equipment Co.

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Frorup, L. E.
Reisinger, Hugo.

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Aitchison Perforated Metal Co., Robert.

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Heck, Louis.
Northwestern Electric Co.

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Dixon Crucible Co., Joseph.
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McLennan Co., K.

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Conover Mfg. Co.
Marshall, Wm. (Electric.)
Stanley Elec. Mfg. Co. (Electric.)

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Fibre Conduit Co.
Gest, G. M.
Gherky, W. D.
National Conduit & Cable Co.
Osburn Flexible Conduit Co.
Rittenhouse Miller Co.
Sprague Electric Co.
Standard Vitrified Conduit Co.

CONDUIT RODS.
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Smith, Hemenway & Co., Corp.

CONSTRUCTION SUPPLIES.
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CONSTRUCTION TOOLS.
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Eastern Arm & Pin Co.

Continued on Page 40.

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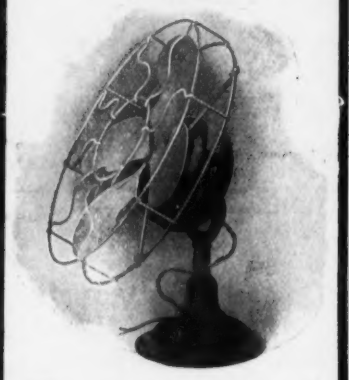

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CLASSIFIED INDEX.—*Continued from Page 40.*

GRAPHITE.
Dixon Crucible Co., Jos.

GREASE.
Dixon Crucible Co., Jos.

HACK SAWS.
Smith, Hemenway & Co., Corp.

HANGER BOARDS.
Ft. Wayne Electric Works.

HARD RUBBER, PERFORATED.
Aitchison Perforated Metal Co., Robert.

HEATING APPARATUS.
Sturtevant Co., B. F.

HEATING BY EXHAUST STEAM.
American District Steam Co.

HOISTS, ELECTRIC AND STEAM.
Case Mfg. Co.
Jeffrey Mfg. Co.
Muralt & Co.
Pawling & Harnischfeger.
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Ostrander & Co., W. R.
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Anderson Mfg. Co., A. & J. M.
Bellevue Porcelain Works.
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Bissell Co., F.
Calman Co., Emil.
Compressed Fibre Co.
Connolly Bros., Ltd.
Crescent Insulated Wire & Cable Co.
Delaware Hard Fibre Co.
Dielectric Mfg. Co.
Driver-Harris Wire Co.
Empire China Works.
Ft. Wayne Electric Works.
Hartford Faience Co.
Hemingray Glass Co.
Imperial Porcelain Works.
Johns-Manville Co., H. W.
Kartavert Mfg. Co.
Kruesi, P. J.
Locke Insulator Mfg. Co.
Mica Insulator Co.
Murdock, H. D.
Munsell & Co., Eugene.
Mustard, John.
National Wire Corporation.
New England Butt Co.
Pass & Seymour, Inc. (China).
Ryle & Co., Wm. (Silk).
Safety Insulated Wire & Cable Co.
Scranton Button Co.
Siemon Hard Rubber Corporation.
Standard Paint Co.
Standard Underground Cable Co.
Standard Vitrified Conduit Co.
Sterling Varnish Co.
Steward Mfg. Co., D. M.
Sunlight Lava Mfg. Co.
Thomas & Sons, R. Thomas.
Trenton Porcelain Co.
United Button Co.
Vulcanized Fibre Co.
Waterbury & Co.

JACKS.
Smith, Hemenway & Co., Corp.
Watson-Stillman & Co.

JUNCTION BOXES.
Bossert Electric Construct. Co.
Central Electric Co.
D. & W. Fuse Co.
General Incandescent Arc Light Co.
Johnson & Morton.

LAMP ADJUSTERS.
Incan. Electric Lt. Manip. Co.
Kinsman Electric & Ry. Supply Co.

LAMPS, ARC.
Adams-Bagnall Elec. Co.
Allgemeine Elektricitats Gesellschaft.
American Electrical Mfg. Co.
Anderson Mfg. Co., A. & J. M.
Bissell & Co., F.
British Thomson-Houston Co.
Brush Elec'l Engineering Co.
Doubleday-Hill Elec. Co.
Ft. Wayne Electric Works.
General Electric Co.
General Incandescent Arc Light Co.
Gregory Electric Mfg. Co.
Stanley Electric Mfg. Co.
Warner, W. F.
Western Electric Co.
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LAMP GUARDS.
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LAMP HOLDERS.
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LAMPS, INCANDESCENT.
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Banner Elec. Co.
Bissell Co., F.
Brilliant Electric Co.
British Thomson-Houston Co.
Brush Elec'l Engineering Co.
Bryan-Marsh Co.
Buckeye Electric Co.
Colonial Electric Co.
Columbia Inc. Lamp Co.
Downward Light Electric Co.
Economical Electric Lamp Co.
Edison Dec. & Min. Lamp Dept.
Franklin Elec. Mfg. Co.
General Electric Co.
General Incandescent Arc Light Co.
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Machado & Roller.
Missouri American Elec. Co.
Munder Elec. Co.
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Phelps Co.
Sawyer-Man Electric Co.
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MOTOR CLOTH AND INSULATING PAPERS.
Standard Paint Co.

Continued on Page 44.

NAME PLATES.
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Crowe Metal Mfg. Co.

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Cincinnati Tool Co.
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Strock, S. C.
Valentine-Clark Co.
Va. Locust Pin Co.
Worcester Co., C. H.

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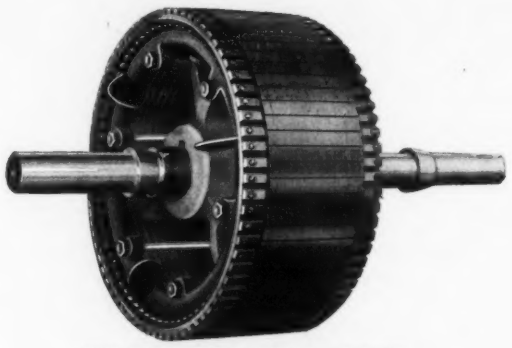

ARMATURE OF TYPE A MOTOR.

TYPE A MOTOR

This is the simplest type of motor extant. The armature is of the "squirrel cage" pattern and wear on the motor is reduced to that which takes place in the bearings. With this type of motor a starting compensator is generally used. The simple device reduces the potential applied to the primary of the motor resulting in a corresponding decrease in the starting current.

TYPE B MOTOR

In this type the starting motor is kept low by introducing starting resistance within the secondary circuit. This motor does not possess the same simplicity of construction as the type A, owing to the fact that the armature has a polar winding and a device for varying the armature resistance is a necessary adjunct in its construction, but it has this advantage—it will start a given load with a current materially less than that taken by the type A. Therefore, it is recommended when the motor must start heavily loaded and where a large current, such as the motor with short-circuited armature takes when starting at full load, would be objectionable.

In addition to the above we also manufacture TYPE C MOTOR for variable speed

STANLEY ELECTRIC MANUFACTURING COMPANY
PITTSFIELD, MASS.

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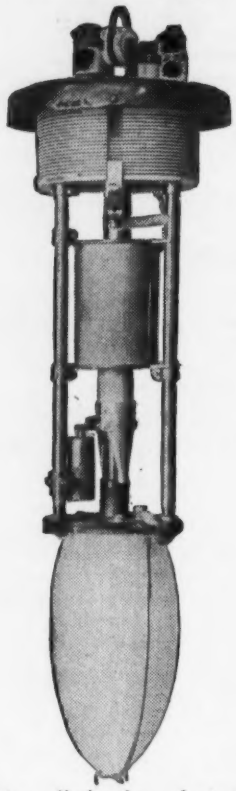

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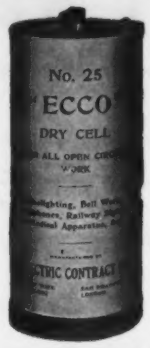

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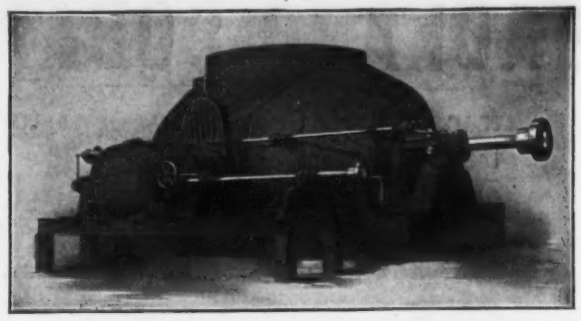

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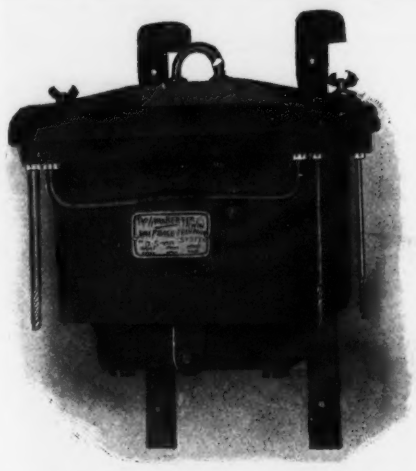

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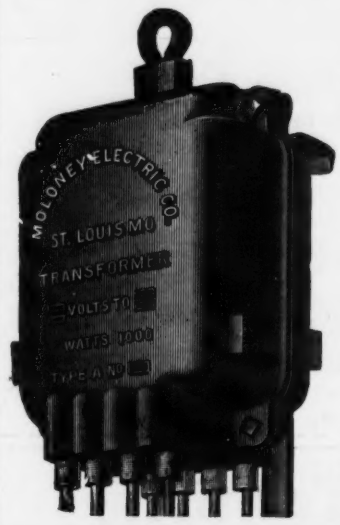

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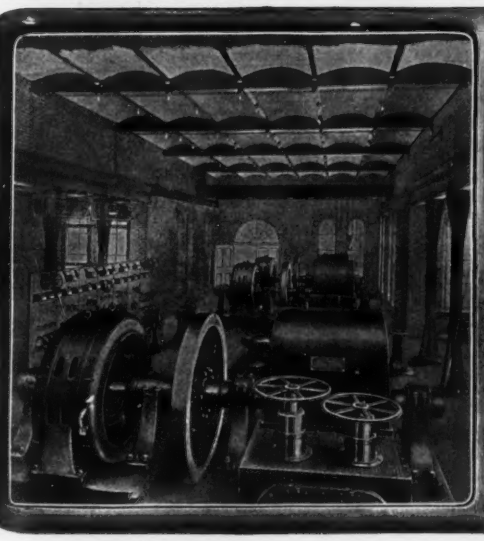

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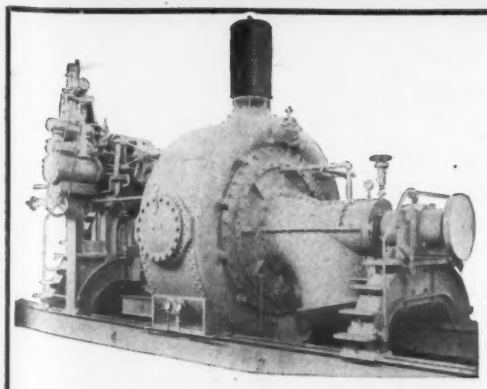

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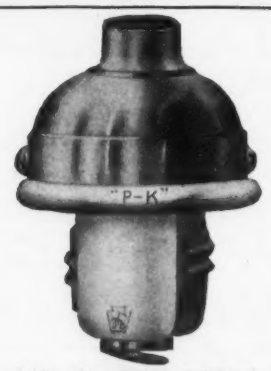

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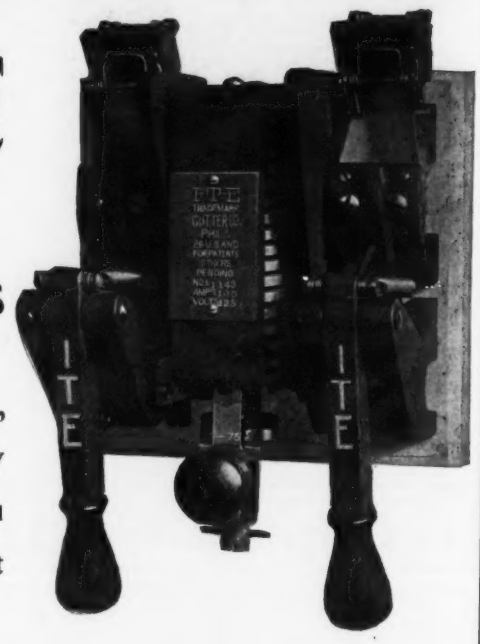

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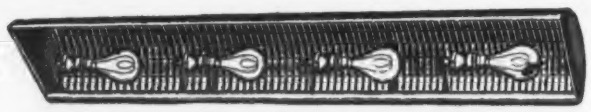

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